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REPORT 160

GROUND-WATER RESOURCES OF NAVARRO COUNTY, TEXAS

By

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ABSTRACT

Navarro County, an area of 1,084 square miles, is in the central part of northeastern Texas. The economy is based primarily on oil production, agriculture, and some manufacturing. The county has a dry subhumid climate in the west and moist subhumid in the east. Annual rainfall, which averages 35 inches in the western part of the county and 39 inches in the eastern part, is sufficient to sustain extensive agricultural development.

About 1.3 mgd (million gallons per day), of ground water was used in the county in 1968 as follows: Public supply, 0.15 mgd; rural domestic, 0.40 mgd; livestock, 0.23 mgd; industry, 0.002 mgd; and irrigation, 0.50 mgd. Most of the water required for public supply and industrial use in the county in 1968 was supplied by surface water obtained from Navarro Mills and other reservoirs.

The principal aquifers and minor water-bearing formations in the county and their approximate quantities of water supplied in 1968 are: Woodbine Formation, 0.13 mgd; Nacatoch Sand, 0.05 mgd; Wilcox, Midway, and Navarro Groups (excluding Nacatoch Sand), and Taylor Marl, 0.60 mgd; and alluvial deposits, 0.50 mgd.

The Hosston Formation, which is untapped by wells in Navarro County, is potentially a valuable source of ground water in the western part of the county. This aquifer presently transmits 1.4 mgd. The Paluxy Sand, which contains fresh to slightly saline water only along the northwestern margin of the county, transmits a quantity of water that is very small chiefly because the amount of saturated sand is thin. The Woodbine Formation transmits 0.4 mgd of which about one-third is pumped in Navarro County. Heavy pumping has caused declines in the water level in the Woodbine of as much as 420 feet from 1907 to 1968. The Nacatoch Sand has considerably less available water than the Woodbine, but drilled wells can pump about 10-15 gpm (gallons per minute) from the aquifer. Alluvium along the Trinity River can yield as much as 150 gpm to wells. The Wilcox Group, Midway Group, Navarro Group (excluding Nacatoch Sand), and Taylor Marl are minor water-bearing units which yield mostly small quantities of water to shallow wells.

Much of the ground water sampled in Navarro County is suitable for many uses. Water from drilled wells in the Woodbine Formation and the Nacatoch Sand, however, generally contains a higher concentration of dissolved solids than water from other geologic units, and therefore is unsuitable for sustained irrigation use.

In 1961, Navarro County produced 25,421,185 barrels of salt water in conjunction with the production of crude oil. Of this amount, 91.3 percent was disposed in open-surface pits or in surface-water courses, but generally no ground-water samples obtained near surface pits showed excesses of chloride that might result from seepage from pits.

GROUND-WATER RESOURCES OF NAVARRO COUNTY, TEXAS

INTRODUCTION

Purpose and Scope of the Investigation

Information on the ground-water resources of Navarro County and on the methods of deriving maximum benefits from the available supplies was obtained during the investigation and is presented in this report. The investigation was begun in October 1967 by the Water Resources Division of the U.S. Geological Survey in cooperation with the Texas Water Development Board.

The scope of the investigation included: The determination of the location and extent of important aquifers; the chemical quality of the water; the quantity of ground water being withdrawn; the hydraulic characteristics of the important water-bearing units; an estimation of the quantity of ground water available for development from each of the important aquifers; and a consideration of all significant ground-water problems in Navarro County.

Records of 241 water wells and oil tests (Table 6), including 56 electrical logs of oil tests and water wells and 15 drillers' logs, were collected and studied. Five of the drillers' logs are given in Table 7. Water samples from 156 wells were collected and analyzed (Table 8). Present and past pumpage of ground water was inventoried, and hydraulic characteristics of various water-bearing units were determined.

The technical terms used in discussing the ground-water resources of the county are defined in the section entitled "Definitions of Terms."

Location and Extent of the Area

Navarro County, an area of 1,084 square miles, is in the central part of northeastern Texas (Figure 1) between latitude 31°47' and 32°20' N and longitude 96°03' and 96°54' W. It is bordered on the northwest by Ellis County, on the northeast by Henderson County, on the southeast by Freestone County, on the south by Limestone County, and on the southwest by Hill County. The Trinity River is the boundary with Henderson County. Corsicana, the county seat, is in the central part of the county, 51 miles south-southeast of Dallas.

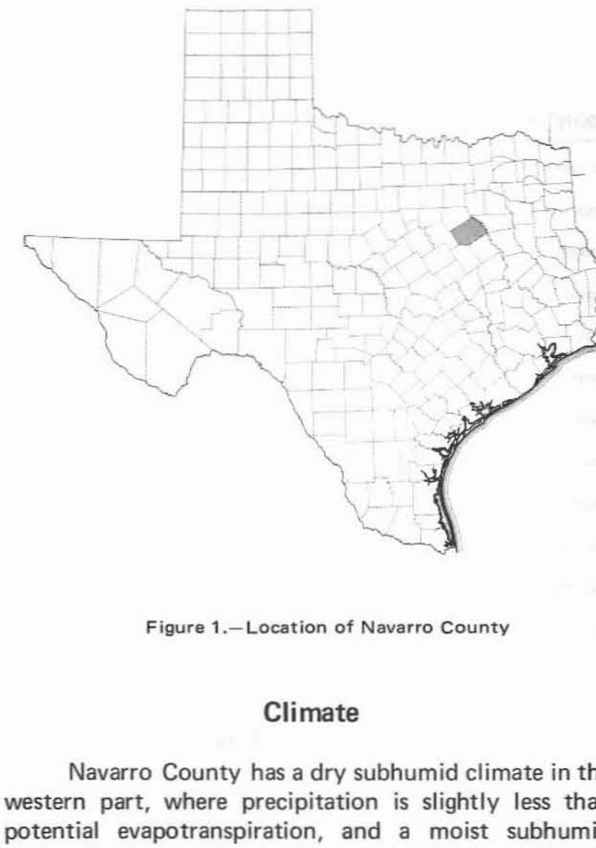

Figure 1.—Location of Navarro County

Climate

Navarro County has a dry subhumid climate in the western part, where precipitation is slightly less than potential evapotranspiration, and a moist subhumid climate in the eastern part, where precipitation is slightly greater than potential evapotranspiration (Thornthwaite, 1952, Figure 30). Annual precipitation, which averages 35 inches in the western part of the county and 39 inches in the eastern part, is sufficient to sustain extensive agricultural development. Hot summers and mild winters generally provide a long growing season of approximately 259 days.

The average annual temperature at Corsicana for the period 1931-60 was 66.4°F (19.1°C). The average annual precipitation at Corsicana was 37.06 inches during the same period, and the average annual gross lake-surface evaporation for the county from 1940 through 1965 was 61.2 inches (Kane, 1967, Table E-11).

The average monthly temperature, precipitation, and gross lake-surface evaporation are listed in Table 1.

Physiography and Drainage

Navarro County is in the northwestern part of the West Gulf Coastal Plain of Texas (Fenneman, 1938, p. 100-107; Deussen, 1924, Figure 2), and includes part of the Black Prairie and the western edge of the East Texas Timber Belt (Fenneman, 1938, pl. VII). Altitudes range from about 240 feet above mean sea level in the southeastern part of the county along the Trinity River to about 630 feet in the northwestern part of the county near Blooming Grove. The Black Prairie, which is underlain by the Taylor Marl, Navarro Group, and Midway Group, is a relatively flat surface that slopes gently to the east. The East Texas Timber Belt, which is underlain by the lower part of the Wilcox Group has a sandy, slightly hummocky surface.

Navarro County is in the drainage basin of the Trinity River. The principal streams within the county are Chambers and Richland Creeks.

Table 1.—Average Monthly Temperature and Precipitation at Corsicana and Average Monthly Gross Lake-Surface Evaporation in Navarro County

MONTH	TEMPERATURE AT CORSICANA (°F)	(°C)	PRECIPITATION AT CORSICANA (INCHES)	GROSS LAKE-SURFACE EVAPORATION IN NAVARRO COUNTY (INCHES)
January	47.0	8.3	2.86	2.5
February	49.9	9.9	3.00	2.6
March	56.4	13.5	2.88	3.6
April	65.2	18.4	4.32	4.1
May	73.2	22.9	4.98	5.1
June	81.6	27.5	3.12	6.4
July	85.3	29.6	1.90	8.0
August	85.4	29.6	2.19	8.6
September	78.7	25.9	2.67	7.1
October	69.2	20.6	2.96	5.9
November	56.1	13.4	2.97	4.3
December	49.2	9.5	3.21	3.0

Economic Development

In 1970, the population of Navarro County was 31,150, of which 80 percent lived in cities or towns of 50 or more inhabitants. The larger cities and towns, with their populations are: Corsicana, 19,972; Kerens, 973; Dawson, 848; Blooming Grove, 740; and Frost, 548.

The economy of Navarro County is based upon oil production, agriculture, and some manufacturing. Diversification to industry and livestock production has reduced the relative economic importance of farming, especially that of cotton. About 60 percent of farm income now comes from livestock and poultry. Cotton production in 1966 was 28,656 bales. Other crops of economic importance in the county are sorghum, corn, wheat, and oats. Livestock and poultry production includes beef cattle, hogs, and chickens.

Industrial activities at Corsicana include the manufacturing of oil-field machinery, cotton textiles, hats, and plastics. A large fertilizer plant is located 1 mile west of the Trinity River near Trinidad.

The present mineral production in decreasing order of value is petroleum, sand and gravel, natural gas, stone, and clay. The total accumulated petroleum production prior to January 1, 1969, was 186,894,625 barrels.

The first significant quantity of petroleum found west of the Mississippi River was discovered in 1894 at Corsicana at a depth of 1,035 feet. The well (TY-33-61-101) was intended to be a municipal water well, but it flowed oil and was still seeping oil in 1968. The earliest production from the Corsicana Shallow Oilfield began in 1896. Crude oil was produced from the Wolfe City Sand Member of the Taylor Marl and Nacatoch Sand of the Navarro Group at the approximate depths of 1,200 and 1,027 feet, respectively. The ensuing oilfields and depths of the producing formations were discovered chronologically as follows: Powell

(Nacatoch at 300 feet) in 1900; Currie (Woodbine Formation at 3,000 feet) in 1922; Richland (Woodbine at 3,300 feet) in 1924; Rice (Wolfe City at 654 feet) in 1938; Bazette (Woodbine at 3,008 feet) in 1939; Angus (Wolfe City and Nacatoch at 1,450 feet) in 1946; Carter-Gragg (Glen Rose Limestone at 6,834 feet) in 1952; Kerens (Woodbine at 3,384 feet) in 1952; Reka (Glen Rose Limestone at 6,832 feet) in 1953; Great Western (Nacatoch at 888 feet) in 1954; Nesbett (Woodbine at 3,390 feet) in 1957; Richland South (Woodbine at 3,336 feet) in 1965; Richland East (Woodbine at 3,171 feet) in 1965; and Pan Ware (Glen Rose Limestone at 6,460 feet) in 1966. The Angus and Rice fields were combined with the Corsicana Shallow Field in 1953 and 1956, respectively.

Previous Investigations

Prior to this investigation, little detailed study had been made of the ground-water resources of Navarro County. The first investigation was made by Hill (1901), who discussed the geology of the Black and Grand Prairies of Texas with special reference to artesian waters. Broadhurst (1943) prepared a report on ground water in the Corsicana-Angus area for the U.S. Corps of Engineers. Sundstrom, Hastings, and Broadhurst (1948) included in their inventory of the public water supplies in eastern Texas the records of public-supply wells, well logs, chemical analyses of water samples, estimates of water consumption, and storage capacity for the principal municipalities in the county. Osborne and Shamburger (1960) discussed brine production and disposal methods in the oil-producing area of Navarro County. They briefly described the geology, tabulated numerous brine-tank batteries, listed 20 chemical analyses of formation water near Corsicana, and showed numerous partial chemical analyses of brine produced near Corsicana and disposed of in nearby streams. Navarro County is included in ground-water reconnaissance investigation of the Trinity River basin by Peckham and others (1963).

Several reports on regional geology in eastern and northern Texas describe the geologic formations in areas in the vicinity of Navarro County. The following reports describe the geology and ground-water resources of other counties in the general area: Baker (1960), Grayson County; Dallas Geological Society (1965), Dallas County; Hendricks (1957), Parker County; Holloway (1961), McLennan County; Leggat (1957), Tarrant County; Scott (1930), Parker County; Shuler (1918), Dallas County; Stramel (1951), Parker County; Thompson (1967), Ellis County; Thompson (1969), Johnson County; and Winton and Scott (1922), Johnson County.

Well-Numbering System

The well-numbering system used in this report is based on the divisions of latitude and longitude and is the one adopted by the Texas Water Development Board for use throughout the State (Figure 2). Under this system, each 1-degree quadrangle in the State is given a number consisting of two digits, from 01 to 89. These are the first two digits of the well number. Each 1-degree quadrangle is divided into 7½-minute quadrangles which are given 2-digit numbers from 01 to 64. These are the third and fourth digits of the well number. Each 7½-minute quadrangle is subdivided into 2½-minute quadrangles given a single digit number from 1 to 9. This is the fifth digit of the well number. Finally, each well within a 2½-minute quadrangle is given a 2-digit number in the order in which it is inventoried, starting with 01. These are the last two digits of the well number. In addition to the 7-digit well number, a 2-letter prefix is used to identify the county. The prefix for Navarro County is TY. Thus, well TY-33-59-102 (which supplies water for the city of Blooming Grove) is in Navarro County (TY), in the 1-degree quadrangle 33, in the 7½-minute quadrangle 59, in the 2½-minute quadrangle 1, and was the second well (02) inventoried in that 2½-minute quadrangle.

The letter prefixes for the counties adjacent to Navarro County for which well data are tabulated in this report are: Ellis County, JK; Freestone County, KA; and Hill County, LW.

On the well-location map in this report (Figure 11), the 1-degree quadrangles are numbered in large bold numbers. The 7½-minute quadrangles are numbered in the northwestern corners of the quadrangles. The three digit number shown with the well symbol contains the number of the 2½-minute quadrangle in which the well is located and the number of the well within that quadrangle.

Acknowledgments

The author is indebted to the property owners in Navarro County for supplying information about their wells and for permitting access to their properties; to the local well drillers for information on water wells; to the city officials and to officials of the water districts who supplied pumpage data and cooperated in pumping tests on their wells. The cooperation of various Federal and State agencies greatly facilitated completion of the project and the report.

Appreciation is expressed to J. L. Meyers Sons and Layne-Texas Company, Inc., Dallas, Texas, for providing information on public-supply wells; and to H. R. Stroube, Jr., Corsicana, Texas, for supplying numerous logs and well locations.

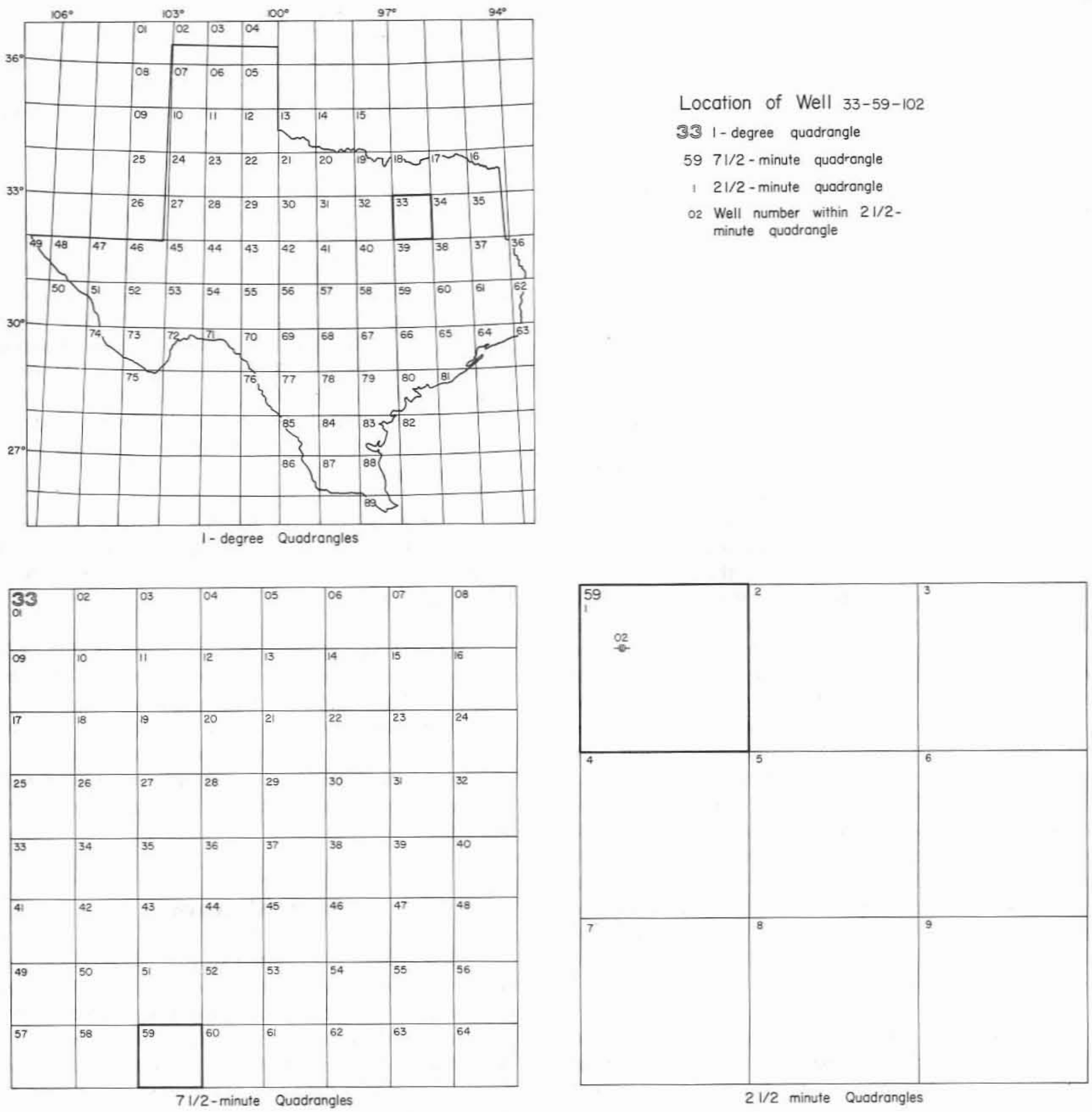

Figure 2
Well-Numbering System

GEOLOGY AS RELATED TO GROUND WATER

General Stratigraphy and Structure

The geologic units that contain fresh to slightly saline water in Navarro County are, from oldest to youngest: The Hosston Formation, Travis Peak (Pearsall)1/ Formation, Paluxy Sand, Woodbine Formation, Taylor Marl, and Navarro Group of Cretaceous age; the Midway and Wilcox Groups of Tertiary age; and the alluvial deposits of Quaternary age. Only the Taylor Marl and younger formations crop out in Navarro County (Figure 3). The subsurface position and depths of the geologic units along a line across Navarro County are shown in Figure 12. The thickness, lithologic characteristics, age, and water-bearing properties of the geologic units are summarized in Table 2. Maximum thicknesses of the geologic units given in this table were determined from interpretations of electrical and drillers' logs.

The Cretaceous rocks unconformably overlie older, nearly impermeable rocks of the Ouachita folded belt which extends from Oklahoma through Navarro County. The pre-Cretaceous rocks, which are commonly crumpled, folded, and faulted (Sellards and others, 1932, p. 128-137), constitute a subsurface wedge of highly indurated sediments.

All formations of Cretaceous age generally trend or strike north-northeastward and dip gently east-southeastward about 50 to 100 feet per mile. The angle of dip gradually increases with increased depth. In areas of faulting, the dip may exceed 250 feet per mile.

The major structural feature in the county is the Mildred-Powell Graben (Osborne and Shamburger, 1960, p. 12), which is a part of the Mexia-Talco Fault system. The rock strata associated with the Mexia-Talco Fault system are intricately faulted and locally folded into a deep structural trough that trends northeastward through the central part of Navarro County. Osborne and Shamburger (1960, p. 12-13) describe the Mildred-Powell Graben as a complex network of *en echelon*, normal faults (Figure 3).

The Mildred Fault bounds the graben on the northwest and the Powell Fault bounds it on the southeast. Stratigraphic displacements along the two principal fault planes range from 150 to 1,000 feet, and increase with depth. Numerous step and right-angle faults displace strata from 40 to 250 feet along and within the margins of the graben.

Study and correlation of the geologic units as recorded by electric logs from various oil tests not used by Osborne and Shamburger (1960) indicate additional extensive fault displacements that are not shown on previously published geologic maps. Major faults dissect the rock strata at various locations in the area extending eastward from a few miles east of Dawson to about 5 miles east of Eureka. Anticlinal folds in the rock strata occur on the upthrown sides of the Mildred Fault, locally near faults in the graben, and on the upthrown southeast side of the Powell Fault.

Some geological literature inappropriately refers to the Mildred-Powell Graben and associated faults as the "Luling-Mexia-Talco Fault system." Murray (1961, p. 178, 180, 184) and Zink (1957, p. 13-22) contend, however, that the Luling system of faults is clearly distinct from the Mexia-Talco system. The distinguishing feature of the Mexia-Talco system is that it constitutes a 28-mile-wide structural belt of *en echelon*, normal faults dipping in opposing directions.

The effect of the Mexia-Talco Fault system on the aquifers in Navarro County is significant. In many areas the throw of the faults is sufficient to place essentially nonwater-bearing formations opposite the aquifers. As a result, circulation of water is greatly retarded and the quality of the water is altered.

Physical Characteristics and Water-Bearing Properties of the Geologic Units

Pre-Cretaceous Rocks

The pre-Cretaceous rocks in Navarro County (Figure 12) are nearly impermeable sediments consisting chiefly of shale, quartzite, and highly indurated sandstone of Pennsylvanian and Jurassic age. No wells are known to obtain water from any pre-Cretaceous rocks in Navarro County, although some oil-test drillers report that some highly mineralized water has been obtained from drill-stem tests in pre-Cretaceous rocks in the county.

Cretaceous System

Hosston Formation

The oldest rocks of the Cretaceous System in Texas are probably stratigraphic equivalents of the Nuevo Leon and Durango Groups in northern Mexico, and of the Hosston and Sligo Formations in southern Arkansas. Imlay (1945) included all rocks of the Cretaceous System older than the Trinity Group in the Nuevo Leon and Durango Groups in the Mexico-Texas region. The rock equivalents of the Nuevo Leon and Durango Groups in Texas underlie the Trinity Group as

1/ The unit at the outcrop is called the Travis Peak Formation; in the subsurface, it is called the Pearsall Formation.

Table 2.—Lithologic Characteristics and Water-Bearing Properties of the Geologic Units

SYSTEM	SERIES	GROUP	GEOLOGIC UNIT	MAXIMUM THICKNESS (FEET)	LITHOLOGICAL CHARACTER OF UNITS	WATER-BEARING PROPERTIES
Quaternary	Holocene Pleistocene		Alluvial deposits	55±	Sand, gravel, silt, and clay.	Yields small quantities of fresh to slightly saline water to shallow irrigation wells along the Trinity River.
Tertiary	Eocene	Wilcox		360±	Fine to medium sands containing clay and silt.	Yields small quantities of fresh to slightly saline water to shallow dug wells for domestic and stock use in far eastern and southeastern parts of county.
	Paleocene	Midway		820±	Multishaded gray to black gypsiferous silty clay, siltstone, glauconitic calcareous sandstone, some sandy glauconitic limestone, and a concretionary limestone bed in upper part.	Yields small quantities of fresh to slightly saline water to shallow dug wells for domestic and stock use in eastern part of county.
Cretaceous	Gulf	Navarro	Nacatoch Sand	202 884	Dark calcareous, sandy, glauconitic clay, and some beds of fine- to medium-grained glauconitic sandstone, above and below the Nacatoch. The Nacatoch Sand includes four sandstone lenses interbedded with light gray shale.	The Nacatoch yields small quantities of fresh to slightly saline water to wells as much as 300 feet deep for stock, domestic, and public supply use; and other beds of the Navarro yield very small quantities of hard water to shallow dug wells for domestic and stock use.
			Taylor Marl Wolf City Sand Member	1,262	Calcareous and sandy shale, glauconitic fine-grained sandstone, and some impure chalk.	The glauconitic sandstone (Wolfe City Sand Member) yields small quantities of fresh hard water to a few shallow dug wells within the outcrop area for domestic and stock use; other beds yield very small quantities of fresh to slightly saline water to shallow dug wells for domestic and stock use in western third of county.
			Austin Chalk and Eagle Ford Shale, undifferentiated	928	Clayey limestone and chalk interbedded with silty and sandy shale, and dark shale containing gypsum and thin beds of sandstone and limestone.	Not a source of fresh or slightly saline water in Navarro County.
			Woodbine Formation	592	Thin- to massive-bedded sandstone interbedded with varying amounts of shale and sandy shale. Upper part of formation contains sandy clay, lignite, gypsum, and nodules of alunite.	A principal aquifer in western third of Navarro County. Water from upper part of formation is more mineralized than from lower part. Formation yields small to moderate supplies of slightly saline water to drilled wells for public supply, industry, domestic, and stock use.
	Comanche	unconformity Washita and Fredericksburg (undifferentiated)		1,270	Limestone, shale, and calcareous, silty, and sandy shale.	Not a source of ground water in Navarro County.
		Trinity	Paluxy Sand	120	Fine-grained, poorly consolidated sandstone and varying amounts of sandy clay, shale, some lignite, and nodules of pyrite.	Contains small amount of water having less than 3,000 mg/l dissolved solids in far western tip of county; but no known wells obtain water from formation in Navarro County.
			Glen Rose Limestone	1,363	Medium- to thick-bedded limestone, and some sandstone, sandy shale, shale, and anhydrite.	Not a source of fresh or slightly saline ground water in Navarro County
			Travis Peak (Pearsall) Formation	662	Coarse- to fine-grained sandstone in upper and lower parts and interbeds of sandstone, shale, and limestone in the middle part. Shale and limestone increase in the middle part downdip.	Small to moderate supplies of slightly saline water are available in western quarter of county, but no known wells in the county obtain water from the form
	Coahuila	Nuevo Leon and Durango	Hosston Formation	289±	Sandstone and sparse interbeds of siltstone, sandy shale, red and green shale, calcareous silty shale, and thin limestone.	An important potential source of small to moderate supplies of slightly saline water in western third of Navarro County. No wells obtain water from the formation in the county.
		(major unconformity)				
Pre-Cretaceous				?	Shale, quartzite, limestone, and indurated sandstone.	Oil-well tests in county indicate highly mineralized water in these rocks.

a subsurface sandstone wedge that extends from southern Arkansas and Louisiana into east Texas.

The deepest water-bearing formation in Navarro County is the Hosston Formation (Table 2), or its stratigraphic equivalent, as identified in McLennan County by Holloway (1961) and in Limestone County by Imlay (1944).

The Hosston or its equivalent in Navarro County underlies the lowest part of the Travis Peak (Pearsall) Formation and is a recognizably distinctive aquifer. In Hill, Johnson, Ellis, and Dallas Counties, drillers refer to the Hosston as the Trinity "sand" or the "second" Trinity.

The Hosston Formation, as defined by Imlay (1945), does not crop out in Navarro County or in central and northeastern Texas, but forms an eastward-thickening subsurface wedge of predominantly clastic rocks underlying the Trinity Group or Sligo Formation. The top of the Hosston ranges in depth from less than 2,960 feet in the western part of Navarro County (Figure 4) to more than 7,790 feet in the eastern part. The dip ranges from 80 feet per mile in the western part of the county to about 130 feet per mile in the eastern part.

Electric and drillers' logs of several oil tests indicate a thick water-bearing sandstone section in the lower half of the formation and scattered interbeds of siltstone, sandy shale, red and green shale, calcareous silty shale, and thin limestone. The thickness of the Hosston Formation in Navarro County, as determined from electrical logs, ranges from about 120 feet in oil test TY-33-54-801 in the northeastern part of the county to more than 289 feet in the southeast (TY-39-07-102) and averages about 215 feet. No wells obtain water from the Hosston in Navarro County, but public-supply well LW-39-10-202 at Hubbard in Hill County taps the Hosston about 6 miles southwest of Dawson. The formation is an important potential source of small to moderate supplies of slightly saline water in the western third of Navarro County.

Trinity Group

The Trinity Group includes from oldest to youngest: The Travis Peak (Pearsall) Formation, the Glen Rose Limestone, and the Paluxy Sand. This group ranges in thickness from 964 feet in oil test TY-39-02-501 in the west to 2,022 feet in oil test TY-33-64-704 in the east, but the maximum composite thickness of the formations forming the group is at least 2,145 feet in Navarro County (Table 2). The group, in general, thickens eastward downdip.

Travis Peak (Pearsall) Formation

The Travis Peak (Pearsall) Formation, which includes the Sycamore Sand, the Cow Creek Limestone, and the Hensell Sand Members, in ascending order, crops out west of Hill and Johnson Counties. Generally, the Travis Peak (Pearsall) consists of coarse- to fine-grained sandstone in the upper and lower parts and interbeds of sandstone, shale, and some limestone in the middle part. Shale and limestone in the middle part increase in thickness in the direction of dip.

The thickness of the Travis Peak (Pearsall) Formation increases eastward, ranging from 240 feet in oil test TY-39-02-501 to a maximum of 662 feet in oil test TY-39-07-401.

No wells in the county are known to obtain water from the Travis Peak (Pearsall). Small to moderate supplies of slightly saline water are available in the western part of Navarro County, but the chemical quality is probably inferior to that of water from the Hosston Formation.

Glen Rose Limestone

The Glen Rose Limestone crops out in the valley of the Brazos River in the extreme west-central part of Johnson County. The Glen Rose consists primarily of medium- to thick-bedded limestone, but contains some sandstone, sandy shale, shale, and anhydrite. The uppermost part of the Glen Rose contains more sandstone and shale than the lower part. The lower part of the Glen Rose contains a massive bed of anhydrite, the Ferry Lake anhydrite of Imlay (1944).

The Glen Rose Limestone thickens eastward in Navarro County. A complete section of the formation ranges in thickness from 650 feet in oil test TY-39-02-202 to at least 1,363 feet in oil test TY-33-64-704, averaging about 940 feet in the county.

Interpretation of electrical logs indicates that the Glen Rose is not a source of fresh or slightly saline water in Navarro County, and local drillers report that they have encountered only highly mineralized water in the formation.

Paluxy Sand

The Paluxy Sand consists predominantly of fine-grained, poorly consolidated sandstone and varying amounts of sandy clay, shale, some lignite, and pyrite nodules. The thickness of the Paluxy is irregular, but the formation generally thickens eastward, ranging from 60 feet in well TY-33-54-801 in the northeastern part of the county, to 120 feet in oil test TY-33-63-802 in the eastern part; the average thickness is about 80 feet. In nonfaulted areas, the formation dips eastward at about 60-70 feet per mile.

No known wells in Navarro County yield water from the Paluxy Sand. Electrical logs indicate that the formation water generally contains more than 3,000 mg/l (milligrams per liter) dissolved solids, except in the far western part of the county, where a small amount of water containing less than 3,000 mg/l dissolved solids occurs.

Fredericksburg and Washita Groups, Undifferentiated

The Fredericksburg and Washita Groups crop out in the western part of Hill County and the outcrop continues westward through Bosque County. From oldest to youngest, the Fredericksburg includes the Walnut Clay, the Goodland Limestone, and the Kiamichi Formation. The Washita Group includes the Duck Creek Limestone, the Fort Worth Limestone, the Denton Clay, the Weno Clay, the Pawpaw Formation, the Main Street Limestone, the Grayson Shale, and the Buda Limestone. The rocks of these groups are mainly limestone and calcareous, silty, and sandy shale. The maximum composite thickness of the Fredericksburg and Washita Groups undifferentiated is 1,270 feet.

The Fredericksburg and Washita Groups are not sources of ground water in Navarro County.

Woodbine Formation

The Woodbine Formation crops out in west-central Hill County. The upper sandy part is distinguished from the lower part because of the distinctive difference in the quality of the water. Water in the upper part contains a larger amount of dissolved solids than in the lower part. The top of the Woodbine is picked on electrical logs (Figure 12) at the top of the highest prominent water-bearing sandstone.

The Woodbine Formation dips to the east-southeast at about 50-70 feet per mile. The top of the formation ranges from less than 940 feet below land surface to a depth of 3,908 feet in oil test TY-33-64-704 in the eastern part of the county (Figure 5).

The Woodbine consists predominantly of thin- to massive-bedded sandstone and varying amounts of interbedded shale and sandy shale. The sandstone is usually thicker in the lower part of the formation than in the upper part. Sandstone facies within the Woodbine are irregular and discontinuous, and correlation of individual beds is difficult. However, the Woodbine's gross characteristics of electrical logs can be traced across the county. Everywhere within Navarro County the Woodbine lies unconformably upon the eroded rocks of the Washita Group.

The upper part of the Woodbine contains much sandy clay interstratified with beds of lignite. Gypsum and nodules of alunite, which contribute to the mineral content of the slightly saline ground water, are common in the uppermost part of this unit.

A complete section of the Woodbine ranges in thickness from about 120 feet in oil test TY-39-05-801 to 592 feet in oil test TY-33-64-704. The formation thickness increases east-northeastward and averages about 345 feet.

The Woodbine is a significant source of slightly saline water for domestic, stock, industrial, and public-supply uses in the western third of Navarro County. Some wells in the Woodbine yield as much as 140 gpm (gallons per minute).

Eagle Ford Shale and Austin Chalk, Undifferentiated

Strata of the Eagle Ford Shale and Austin Chalk crop out in belts that trend north-northeastward across eastern Hill and western Ellis Counties. The Eagle Ford Shale is a moderately fossiliferous, bluish-black shale containing gypsum and thin beds of sandstone and limestone. The Austin Chalk consists of clayey limestone and chalk interstratified with soft silty to sandy shale. The maximum composite thickness in Navarro County is about 928 feet (Table 2).

The Eagle Ford Shale and Austin Chalk are not sources of fresh or slightly saline ground water in Navarro County.

Taylor Marl

Rocks of the Taylor Marl crop out in the western third of the county. These rocks consist mainly of shale with irregular or lenticular beds of sandstone, calcareous and sandy shale, and impure chalk that constitutes four stratigraphic units in the following ascending order: Undifferentiated calcareous and sandy shale, Wolfe City Sand Member, Pecan Gap Chalk Member, and undifferentiated calcareous shale. The latter is indistinguishable on electric logs from the overlying basal beds in the Navarro Group; consequently the geologic contact between the Taylor Marl and the Navarro Group is shown as a dashed line in Figure 12. The thickness of the Taylor, as estimated from electric logs in Navarro County, ranges from 1,262 feet in oil test TY-39-05-302 to 826 feet in oil test TY-33-54-805.

A few old shallow dug wells tap the outcrop of the Wolfe City for domestic and livestock use. These wells

yield only small quantities of fresh hard water. No wells are known to produce water from the Wolfe City east of the outcrop, and most electric logs indicate highly mineralized water a few hundred feet below land surface.

Shallow dug wells in the Taylor Marl, excluding the Wolfe City Sand Member, usually yield very small quantities of fresh to slightly saline water for domestic and stock use.

Navarro Group

The outcrop of the Navarro Group trends north-northeastward through central Navarro County. It consists of beds of dark or greenish-gray calcareous, sandy, glauconitic, fossiliferous clay and shale, and several thick beds of fine- to medium-grained glauconitic sandstone. The group is divisible into four formations in the following ascending order: Neylandville Marl, Nacatoch Sand, Corsicana Marl, and Kemp Clay. The maximum thickness of the Navarro Group, as estimated from electric logs, is 884 feet.

The Nacatoch Sand is the principal aquifer of the Navarro Group. The Nacatoch consists of lenticular beds of sandstone interbedded with light gray shale. Locally, the Nacatoch contains four well-developed sandstone lenses. The thickness of the formation ranges from 120 feet in oil test TY-39-12-603 to 202 feet in oil test TY-33-54-206 and averages about 160 feet. In the area of outcrop and downdip, the beds of sandstone yield small quantities of fresh to slightly saline water to stock, domestic, and public-supply wells from depths as much as 300 feet. Only meager information is known about the fresh water-salt water interface, which appears to be rather irregular. Moderately saline water is reported to readily replace fresh water that is withdrawn from the formation in some areas along the outcrop.

Other formations of the Navarro Group yield very small quantities of hard water to shallow dug wells for domestic and stock use.

Tertiary System

Midway Group

The Midway Group crops out in a north-northeastward trend across east-central Navarro County and attains a maximum known thickness of about 820 feet. Two principal formations constitute the Midway in the County: The Kincaid Formation (lower unit) and the Wills Point Formation (upper unit).

The Kincaid Formation consists of greenish and dark gray gypsiferous clays, sandy glauconitic limestone, and glauconitic calcareous sandstone. The glauconitic limestone unit marking the top of the Kincaid Formation is the Tehuacana Member. Until 1960, the Tehuacana Member in Limestone County supplied moderate quantities of fresh to slightly saline water to the municipal wells of Mexia, 29 miles south of Corsicana (Burnitt, Holloway, and Thornhill, 1962, p. 9, 13). No wells are known to produce water from the Tehuacana in Navarro County.

The Wills Point Formation consists of dark bluish gray to black silty clay or claystone, some siltstone, and a very thin, impure concretionary limestone bed.

The Midway Group yields small quantities of fresh to slightly saline water to shallow dug wells in the eastern part of the county for domestic and stock use.

Wilcox Group

The lower part of the Wilcox Group crops out in the extreme eastern part of the county. The outcrop extends from Streetman northeastward to U.S. Highway 287, thence roughly northward to the Trinity River. The maximum thickness of the group in Navarro County is about 360 feet (calculated from an assumed dip of 40 feet per mile east-southeast) near the intersection of Henderson, Freestone, and Anderson Counties.

The Wilcox is a fine to medium sand containing clay and silt. A bright-red to reddish-brown soil characterizes the surface.

The Wilcox Group yields small quantities of fresh to slightly saline water to shallow dug wells for domestic and stock use in far eastern and southeastern parts of the county.

Quaternary Alluvial Deposits

Alluvial deposits veneer the strata of Cretaceous and Tertiary age in Navarro County below the flood plain of the principal stream channels and on some of the upland stream divides. The deposits along the Trinity River are as much as 55 feet thick; the upland alluvial deposits are very thin and not a source of ground water.

The flood-plain alluvium along the stream channels consists of material eroded from outcropping strata within the drainage basin. The alluvium is generally a moderately to well sorted, stratified detritus of rounded gravel, sand, silt, and clay. Generally, the coarsest material occurs at the base. Wells should penetrate the entire thickness of the alluvium for the greatest yield.

Alluvial deposits in Navarro County are as much as two miles wide along the lower reaches of the principal streams and as much as three miles wide west of the main channel of the Trinity River in the northeastern part of the county. Most of the Trinity River flood plain lies east of the river in Henderson County.

The alluvial deposits underlying the flood plain along the principal streams yield small quantities of fresh ground water to wells. Several 20-inch diameter wells are drilled to depths of 50 feet in the alluvium of the Trinity River near well TY-33-54-204 but none of them reached the base of the alluvium. These wells, which are equipped with 5-horsepower pumps, individually yield as much as 30 gpm of fresh to slightly saline water. Because the wells are used primarily for irrigation, their use is seasonal. The quality of the water varies locally, but water from the alluvium is the only significant supply of ground water that is suitable for sustained irrigation in Navarro County.

GROUND-WATER HYDROLOGY

Source and Occurrence of Ground Water

The primary source of ground water in Navarro County is the infiltration of precipitation, either directly in the outcrop areas or indirectly as seepage of streamflow. A large part of the precipitation becomes surface runoff because it moves rapidly down the hilly surfaces or across nearly impermeable rocks. If the rain is intense, the proportion of surface runoff increases because the time available for absorption is inadequate even in very sandy areas. Much of the water evaporates at the land surface, is transpired by plants, or remains in the subsoil. A small part of the precipitation infiltrates to the water table or saturated zone. In the saturated zone, the water fills all the intergranular spaces in the rocks and becomes ground-water recharge to the water-bearing formations. The water then moves down the hydraulic gradient into the artesian sections of the aquifers.

Ground water occurs under either water-table or artesian conditions. Many publications describe the general principles of the occurrence of ground water in all kinds of rocks: Meinzer (1923a, p. 2-142; 1923b), Todd (1959, p. 14-114), Baldwin and McGuinness (1963), and De Wiest (1965). Ground water in the outcrop areas of the formations and in the alluvial deposits generally is unconfined under water-table conditions. Water under these conditions does not rise above the level where it is first encountered in a well. In most places, the configuration of the water table approximates the topographic form of the land surface. About 80 percent of the water wells in Navarro County in Table 6 are less than 60 feet deep, and they penetrate only those parts of the water-bearing units under water-table conditions.

Downdip from the outcrop, the aquifer may underlie a relatively impermeable layer of rock. The water in this part of the aquifer is under confined (artesian) conditions. Here, the hydrostatic pressure is nearly equal to the weight of a column of water extending upward from the aquifer where tapped by a well to the altitude of the water table in the area of outcrop of the aquifer. Where the altitude of the land surface at the well is below the altitude of the water level in the outcrop, the hydrostatic pressure of the water may be sufficient to raise the water level in the artesian well to an altitude substantially above the top of the aquifer—possibly high enough for the well to flow. Before 1930, the hydrostatic pressure in the Woodbine Formation was great enough for some wells tapping this aquifer to flow.

The static level to which water rises in wells in an artesian aquifer forms an imaginary surface of the hydrostatic pressure called the potentiometric surface. The potentiometric surface usually slopes downward from the areas of outcrop, the amount of slope depending on the permeability of the water-bearing material and the quantity of water flowing through the aquifer.

Recharge, Movement, and Discharge of Ground Water

Ground water moves, under the force of gravity, from the areas of recharge to the areas of discharge. The recharge of ground water to the aquifers in Navarro County is chiefly from precipitation on the outcrops of the aquifers in and west of the county. The average annual precipitation ranges from about 30 inches per year on the Travis Peak (Pearsall) Formation west of Johnson County to about 39 inches on the Wilcox Group in the eastern part of Navarro County. Only a small percentage of this precipitation becomes recharge. The exact quantity of recharge to the aquifers in Navarro County is not known, but on the basis of previous studies in the general area, the quantity on the sandy parts of the outcrops of the aquifers is estimated to be about 0.5 inch per year.

The dominant direction of water movement after initial infiltration is downward, under the force of gravity, through the unsaturated zone to the water table and saturated zone. In the saturated zone, the movement of water generally is horizontal in the direction of decreasing head or pressure. The rate of movement is rarely uniform, but is directly proportional to the hydraulic gradient, which tends to steepen near areas of natural discharge or pumping wells. In much of Navarro County where the land surface is flat to gently rolling, the profile of the water table in the outcropping geologic units tends to parallel a subdued topographic profile, and water may move locally in the direction of the land-surface slope.

Although rock formations consisting predominantly of clay or shale are not regarded as aquifers, water nevertheless moves through such formations and they slowly yield very small quantities of ground water. The clayey or shaly members of the Taylor Marl, Navarro Group, and Midway Group are examples of such formations. Lateral ground-water movement in these units probably does not exceed a few feet per year because of their very low hydraulic conductivity.

No water wells in Navarro County obtain water from the Hosston Formation, Travis Peak (Pearsall) Formation, or Paluxy Sand, and water-level data for the Woodbine Formation are not sufficient for the preparation of a potentiometric map for that aquifer; however, the few data available indicate that the movement of water in the Woodbine is generally eastward in the direction of structural dip and that the rate of movement is from 6 to 40 feet per year.

Water in the subsurface moves in response to differences in hydrostatic pressures within an aquifer, but the water may move vertically from one aquifer to another through overlying semiconfining beds or along fault planes, which are common in central Navarro County. Ground water may ultimately move from deeper formations to shallower, more permeable rocks.

Fresh to slightly saline water in the aquifers in Navarro County moves constantly toward areas of natural or artificial discharge. Most natural discharge is by seepage to streams and marshes where the water table intersects the land surface, transpiration, and evaporation from the soil. Artificial discharge is by pumping wells.

Hydraulic Characteristics of the Aquifers and Minor Water-Bearing Units

The value of an aquifer as a source of ground water depends principally upon the capacity of the aquifer to transmit and to store water. The transmissivity, hydraulic conductivity, and storage coefficient, which may be determined by aquifer tests, are the measurements of this capacity. The water-bearing characteristics of an aquifer may vary considerably in short distances, depending upon lithologic and structural changes within the aquifer. Consequently, a single aquifer test can only be used to measure the aquifer's capacity in a small part of the total aquifer.

The transmissivity and storage coefficient may be used to predict the drawdown or decline in water levels caused by pumping from the aquifer. Pumping from a well forms a cone of depression in the potentiometric surface or water table. Pumping from wells drilled close together may create cones of depression that intersect, thereby causing additional lowering of the potentiometric surface or water table. The intersection of cones of depression, or interference between wells, results in lower pumping levels (and increased pumping costs) and can cause serious declines in yields of the wells. The proper spacing of wells, determined from aquifer-test data, minimizes interference between wells. (See section on "Definitions of Terms".)

Aquifer-test data in Navarro County were obtained from the drillers' records of two wells tapping the Nacatoch Sand at Roane and from one well tapping the Woodbine Formation at Blooming Grove. To obtain estimates of the hydrologic characteristics of the Hosston Formation in Navarro County as well as additional characteristics of the Woodbine, aquifer-test data from adjacent counties were used, and electric and drillers' logs were studied.

The results of an aquifer test made in well LW-39-10-202, which is screened opposite 63 feet of possibly 75 feet of the Hosston Formation at Hubbard in Hill County, indicated a transmissivity of 4,200 gpd (gallons per day) per foot. On the basis of the 75 feet of saturated sand in this well, the hydraulic conductivity is about 56 gpd per square foot. A comparison of the electrical and drillers' logs in the two counties indicates that the average hydraulic conductivity for the Hosston in Navarro County probably is on the order of 50 gpd per square foot. If the thickness of saturated sand in the Hosston in Navarro County averages 130 feet, which is conservative, the average transmissivity would amount to 6,500 gpd per foot. The storage coefficient for the Hosston Formation could not be determined from the aquifer test, but it probably is similar to that determined for the Hosston in Ellis County—about 0.00008 (Thompson, 1967, p. 33). The specific capacity determined from the test in the Hosston at Hubbard was 1.12 gpm per foot.

The time-distance-drawdown curves for the Hosston Formation (Figure 6), based on a transmissivity of 6,500 gpd per foot and a storage coefficient of 0.0001 (rounded from 0.00008), show that a well pumped continuously at the rate of 100 gpm for one year theoretically will lower the water level about 16 feet at a distance of 1,000 feet from the pumped well, and about eight feet at a distance of 10,000 feet. At the same pumping rate and distances, the water levels would be lowered about 20 feet and about 12 feet, respectively, after 10 years.

No aquifer tests were made on the Travis Peak (Pearsall) Formation or the Paluxy Sand, because no wells tap these formations in Navarro County. A lower hydraulic conductivity for the Travis Peak (Pearsall) relative to that of the Hosston is indicated by electrical logs which show a higher percentage of clay and shale and less total saturated sand in the Travis Peak (Pearsall) Formation than in the Hosston Formation.

An aquifer test was made in public-supply well TY-33-59-102 tapping the Woodbine Formation at Blooming Grove. The transmissivity from an adjusted recovery test was 3,500 gpd per foot; the hydraulic conductivity from this test was 31 gpd per square foot, and the specific capacity was 2.1 gpm per foot. The storage coefficient was not determined, but aquifer tests in Johnson County at Grandview, 45 miles west-northwest of Corsicana, indicated a storage

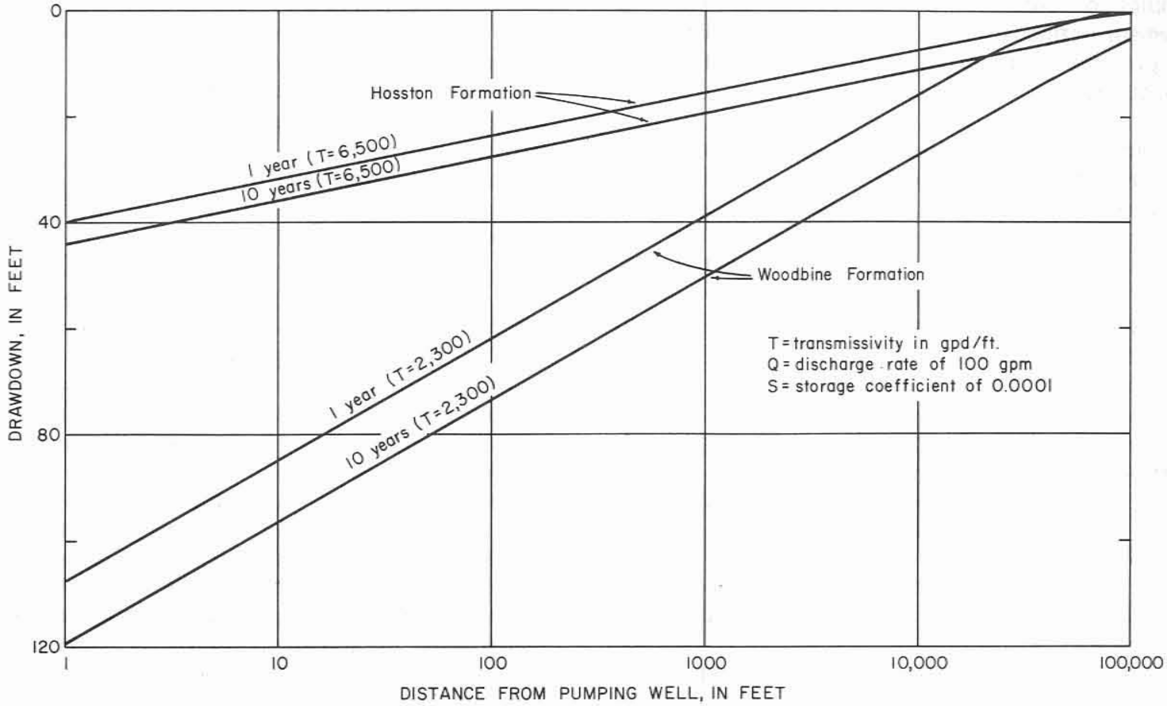

Figure 6.—Relation of Drawdown to Distance and Time in Pumped Aquifers

coefficient of 0.00007 in the Woodbine (Thompson, 1969, p. 30), which is probably applicable in Navarro County.

The thickness of the saturated sand containing slightly saline water in the Woodbine Formation in Navarro County averages 76 feet. Based on this thickness and assuming an average hydraulic conductivity of 30 gpd per square foot for the county, the average transmissivity for the Woodbine in the county is about 2,300 gpd per foot (Figure 6). This is contrasted to 9,500 gpd per foot in Ellis County where the sand thickness is considerably greater and the aquifer is more permeable.

Aquifer tests of the Nacatoch Sand in Navarro County were not feasible during the investigation, but at Roane, in public-supply wells TY-33-53-602 and TY-33-53-603, the specific capacities derived from driller's test data were 0.09 gpm per foot (after pumping 10 gpm for six hours) and 0.33 gpm per foot (after pumping 10-12 gpm for seven hours), respectively. Each well had a gravel-packed 25-foot screen four inches in diameter. These data suggest that transmissivity and hydraulic conductivity are very low for both wells.

Extremely low specific yield and low hydraulic conductivity but high porosity and high specific retention characterize the hydraulic properties of clay-size sediments (Todd, 1959, p. 24). For these reasons, wells obtaining water from the predominantly clayey beds in the Taylor Marl and Navarro and Midway Groups produce only very small quantities of water, usually less than 10 gpm; and the wells may go dry temporarily due to either overpumping or a lowering of the water table during periods of drought.

Development of Ground Water

About 1.3 mgd (million gallons per day) of ground water was used in Navarro County during 1968 for public supply, industry, irrigation, rural domestic needs, and livestock (Table 3). Although surface water from Navarro Mills Reservoir and other reservoirs recently constructed is the major source of water supply for municipal and industrial use in Navarro County (about 3 mgd of surface water was used in 1968), vital quantities of ground water are used for public supply and industry in the western third of the county; and considerable quantities of ground water are used for domestic and livestock needs throughout the county. Except for general livestock consumption, irrigation in northeastern Navarro County is the largest ground-water user. This irrigation water comes from alluvial flood-plain deposits along the Trinity River. The Hosston Formation is untapped, and constitutes a valuable potential source of ground water in the western part of Navarro County.

Records of 241 wells and test holes were obtained in Navarro County and adjacent areas (Table 6) during the ground-water investigation. The inventory included

Table 3.—Use of Ground Water, in Millions of Gallons Per Day, From the Geologic Units, 1968

AQUIFER OR WATER-BEARING UNIT	PUBLIC SUPPLY	IRRIGATION	INDUSTRIAL	LIVESTOCK	RURAL DOMESTIC	TOTALS
Alluvial deposits	0	0.500	0	0	0	0.500
Nacatoch Sand	.020	0	.001	.012	.020	.053
Wilcox Group, Midway Group, Navarro Group (excluding Nacatoch Sand), and Taylor Marl	0	0	0	.221	.380	.601
Woodbine Formation	.129	0	.001	0	0	.130
TOTALS	0.149	0.500	0.002	0.233	0.400	1.284

only a part of the total number of wells in the county. Locations of the inventoried wells and test holes in Navarro and adjoining counties are shown in Figure 11.

Of the total ground water pumped for all uses in Navarro County in 1968, about 0.130 mgd came from the Woodbine Formation, about 0.053 mgd came from the Nacatoch Sand, about 0.500 mgd came from the alluvium, and about 0.601 mgd was obtained from the predominantly clayey beds in the Taylor Marl, Navarro Group, Midway Group, and the clayey sand of the Wilcox Group.

Public Supply

Ground water was used in 1968 for public supply in seven municipalities in Navarro County. Blooming Grove and Frost used about 80 percent of the total. The pumpage of ground water for all public-supply uses decreased from a reported 0.16 mgd in 1955 to about 0.15 mgd in 1968. The decrease in the use of ground water for public supply since 1955 probably resulted from a general decrease in population in the small towns. Yearly fluctuations in precipitation cause variations in local annual use. A newly formed rural cooperative surface-water public-supply system drawing from Navarro Mills Reservoir began operation and expansion in 1967. Much of the rural domestic and municipal-supply water used in the county is now supplied by an extensive cooperative system.

Blooming Grove is currently the largest user of ground water for public supply. During 1968, Blooming Grove used a total of 0.066 mgd which is 44 percent of all ground water used for public supply in the county that year, or about 5 percent of the total of all ground water used. The water is pumped from two wells in the Woodbine Formation at depths of 1,514 and 1,450 feet.

Frost is the second largest user of ground water for public supply. In 1968, Frost used a total of 0.049 mgd which is 33 percent of all public-supply ground water used in the county that year, or about four percent of the total ground water used. Frost obtains its water from one well that taps the Woodbine Formation at a depth of 1,184 feet.

Other water systems in Navarro County that used ground water for public supply in 1968 were: Richland, about 0.015 mgd from the Nacatoch Sand; Barry, about 0.006 mgd from the Woodbine Formation; Roane, about 0.005 mgd from the Nacatoch; Emhouse, about 0.004 mgd from the Woodbine; and Purdon, about 0.004 mgd from the Woodbine.

Industrial Use and Irrigation

Most industry in Navarro County used water either from a surface-water supply or from the local public ground-water supply. However, Frost had two cotton gins that pumped about 0.001 mgd from the Woodbine Formation, and the Texas Pipe Line Company at Corsicana pumped about 0.001 mgd from the Nacatoch Sand in 1968. The total ground water used for industry in the county during 1968 was about 0.002 mgd (Table 3).

Ground water from Trinity River alluvial deposits is used for irrigation in Navarro County. In the northeastern part of Navarro County, a 1,112-acre tract of land is irrigated with water from 12 wells (TY-33-54-101 through TY-33-54-205 and well TY-33-46-801) that are about 50 feet deep (Table 6). The quantity of ground water used for irrigation in 1968 was 560 acre-feet (about 0.50 mgd).

Rural-Domestic and Livestock Use

The average annual quantities of ground water used for rural domestic needs in Navarro County since 1955 was influenced by three factors: The gradually increasing daily requirement of water per capita because of modernization of rural homes; expansion in the surface-water rural public-supply system; and a large number of cisterns in use in the county.

In 1955, the county's rural population of about 8,711 used an estimated 0.17 mgd of ground water. By 1968, the rural population of about 8,000 used an estimated 0.40 mgd (Table 3); this is 31 percent of the total ground water used in the county in 1968 for all needs.

The quantity of ground water used in 1968 for livestock was about 0.23 mgd. This is 18 percent of all ground water used in the county in that year for all needs.

In summary, pumpage for rural domestic and livestock needs was about 0.63 mgd, which is about 49 percent of all ground water used in the county in 1968. Of the domestic and stock wells in use, about six percent tap the Nacatoch Sand and the remaining wells tap the Woodbine, Taylor Marl, Navarro Group (excluding Nacatoch Sand), Midway and Wilcox Groups, and the alluvium.

Well Construction

Most wells in the county were dug or bored although a few of the deeper wells were drilled. Almost all drilled wells in Navarro County were completed after 1930.

The shallow dug wells constitute about 95 percent of all water wells in Navarro County. Most of the dug wells that were inventoried were less than 60 feet deep and ranged in diameter from about 20 to 40 inches. The yields are very small because the wells penetrate only a few feet of saturated material that is usually silty clay or shale having low permeability.

The few bored wells in the county are cased with tile, range from 8 to 34 inches in diameter, and average 37 feet in depth. The yields of these wells are small because the water enters the wells only through the joints of the tile casings.

The drilled, predominantly metal-cased wells, which have the largest yields, range from 4 to 20 inches in diameter; 4-inch diameters are most common. Some domestic wells drilled in the county in recent years are 4-inch diameter wells that penetrate from 100 to 300 feet of rock. These wells have 10 to 20 feet of slotted or perforated metal casing opposite permeable sandstone.

The public-supply wells in Navarro County are generally larger in diameter and deeper than the drilled domestic wells. Of those inventoried, all but one ranged from 4 to 8 inches in diameter and from 119 to 1,750 feet in depth. An example of well construction that is characteristic of public-supply wells in the county is shown by Figure 7. A few wells drilled for some public-supply systems utilize a perforated casing opposite the water-bearing strata rather than a gravel-packed screen as shown in Figure 7. A well having perforated casing is considerably less efficient and more expensive to operate than a screened well. Sand may be pumped with the water from a loose, very fine to fine sand aquifer. This sand reduces the effective life of most pumps, especially submergible pumps. A properly gravel-packed well will greatly reduce the sand intake and thus lengthen the life of the pump.

Figure 7.—Construction of a Typical Public-Supply Well

Changes in Water Levels

Water levels in wells continuously respond to natural and artificial influences that act upon all water-bearing rocks. In general, the major influences that control water levels are the rates of recharge to and discharge from the water-bearing rock. Relatively minor water-level changes in aquifers are due to variations in atmospheric pressure. Water-level fluctuations are usually gradual, but in some wells the water levels may rise or fall several inches or several feet in a few minutes. Such rapid and large-scale fluctuations usually result from the starting or stopping of pumps in wells.

Water-level declines of considerable magnitude usually result from large withdrawals of water from wells. A lowering of the water table represents an actual dewatering of the aquifer usually in or near the aquifer's outcrop; the lowering may reflect lack of recharge, especially during drought conditions, or local overpumping from the water-bearing unit. Where artesian conditions prevail, a lowering of the static water level represents a decrease in artesian pressure in the aquifer; but the change in the actual quantity of water in storage may be small.

Long-term records of annual fluctuations of water levels in Navarro County are not available, but information on long-term net changes in water levels is afforded by records for several artesian wells in the county. Water levels declined 420 feet, or an average of about seven feet per year, from 1907 to 1968 in wells tapping the Woodbine. In well TY-33-59-302 tapping the Woodbine at Barry, water levels declined from 18 feet below land surface in 1917 to 384 feet below land surface in 1968, an average of 7.2 feet per year. The declines in water levels in wells tapping the Woodbine were caused partly by pumping in Navarro County and probably to a greater extent by heavier pumping in Ellis County. Recent water levels in wells tapping the Nacatoch Sand indicated only slight fluctuations.

QUALITY OF GROUND WATER

The chemical constituents in the ground water in Navarro County are derived principally from the most soluble materials in the soil and rocks through which the water has moved. The differences in the chemical quality of the water reflect, in a general way, the types of soil and rocks that have been in contact with the water and the length of time in contact. Usually, as the water moves deeper, its chemical content increases. The source and significance of the dissolved-mineral constituents and other properties of ground water are summarized in Table 4, which is modified from Doll and others (1963, p. 39-43). The results of 165 chemical analyses of water from 156 selected wells in Navarro and Freestone Counties are given in Table 8. The chloride, sulfate, dissolved-solids content, and source of water for samples from selected wells are shown on Figure 8.

Suitability of Water for Use

The suitability of a water supply depends upon the requirements of the contemplated use of the water. In addition to chemical quality, other requirements may include bacterial, pesticide, algal, and plankton content, turbidity, color, odor, temperature, and radioactivity.

The U.S. Public Health Service has established and periodically reviews the standards for drinking water used on common carriers engaged in interstate commerce. The standards are designed to protect the public and are used to evaluate public water supplies.

According to the U.S. Public Health Service (1962, p. 7-8), chemical substances should not exceed the listed concentrations whenever more suitable supplies are available or can be made available.

COMMON CONSTITUENTS IN WATER

SUBSTANCE	CONCENTRATION MG/L 1/
Chloride (Cl)	250
Fluoride (F)	1.0 2/
Iron (Fe)	.3
Nitrate (NO_3)	45
Sulfate (SO_4)	250
Dissolved solids	500

1/ mg/l (milligrams per liter) is considered equivalent to ppm (parts per million) for waters containing less than 7,000 mg/l dissolved solids.

2/ The permissible concentration of fluoride in Navarro County is based upon the annual average of maximum daily air temperature of 78°F (26°C) at Corsicana for the period 1931-60.

Much of the ground water sampled in Navarro County, except that from the Woodbine Formation, meets the standards established by the Public Health Service, and the wells generally yield water that is suitable for many uses. Water from the Woodbine and Nacatoch aquifers (Table 8), however, is unsuitable for sustained irrigation.

The dissolved-solids or "total salts" content is a major limitation on the use of water for many purposes. In this report, the classification of water (Salinity of Water, p. 91) based on the dissolved-solids content in mg/l, is from Winslow and Kister (1956, p. 5).

Chemical Quality of Ground Water in the Geologic Units

The concentration of dissolved solids (Table 8) ranged from 37 mg/l in well TY-39-05-703 tapping the Midway Group to 9,670 mg/l in water from well TY-33-59-301 tapping the Woodbine, which is probably contaminated by leakage through a corroded well casing from the Wolfe City Sand Member of Taylor Marl. Of the samples analyzed for dissolved solids (Table 8), about 83 percent exceeded the 500 mg/l limit recommended by the U.S. Public Health Service and 57 percent exceeded 1,000 mg/l. Of the samples in which approximate dissolved solids are calculated from specific conductance (Table 8) plus the laboratory determinations of dissolved solids, 61 percent of all water samples exceeded the 500 mg/l limit, but only 35 percent exceeded 1,000 mg/l.

Table 4.—Source and Significance of Dissolved-Mineral Constituents and Properties of Water

CONSTITUENT OR PROPERTY	SOURCE OR CAUSE	SIGNIFICANCE
Silica (SiO_2)	Dissolved from practically all rocks and soils, commonly less than 30 mg/l. High concentrations, as much as 100 mg/l, generally occur in highly alkaline waters.	Forms hard scale in pipes and boilers. Carried over in steam of high pressure boilers to form deposits on blades of turbines. Inhibits deterioration of zeolite-type water softeners.
Iron (Fe)	Dissolved from practically all rocks and soils. May also be derived from iron pipes, pumps, and other equipment. More than 1 or 2 mg/l of iron in surface waters generally indicates acid wastes from mine drainage or other sources.	On exposure to air, iron in ground water oxidizes to reddish-brown precipitate. More than about 0.3 mg/l stains laundry and utensils reddish-brown. Objectionable for food processing, textile processing, beverages, ice manufacture, brewing, and other processes. U.S. Public Health Service (1962) drinking-water standards state that iron should not exceed 0.3 mg/l. Larger quantities cause unpleasant taste and favor growth of iron bacteria.
Calcium (Ca) and magnesium (Mg)	Dissolved from practically all soils and rocks, but especially from limestone, dolomite, and gypsum. Calcium and magnesium are found in large quantities in some brines. Magnesium is present in large quantities in sea water.	Cause most of the hardness and scale-forming properties of water; soap consuming (see hardness). Waters low in calcium and magnesium desired in electroplating, tanning, dyeing, and in textile manufacturing.
Sodium (Na) and potassium (K)	Dissolved from practically all rocks and soils. Found also in ancient brines, sea water, industrial brines, and sewage.	Large amounts, in combination with chloride, give a salty taste. Moderate quantities have little effect on the usefulness of water for most purposes. Sodium salts may cause foaming in steam boilers and a high sodium content may limit the use of water for irrigation.
Bicarbonate (HCO_3) and carbonate (CO_3)	Action of carbon dioxide in water on carbonate rocks such as limestone and dolomite.	Bicarbonate and carbonate produce alkalinity. Bicarbonates of calcium and magnesium decompose in steam boilers and hot water facilities to form scale and release corrosive carbon dioxide gas. In combination with calcium and magnesium, cause carbonate hardness.
Sulfate (SO_4)	Dissolved from rocks and soils containing gypsum, iron sulfides, and other sulfur compounds. Commonly present in mine waters and in some industrial wastes.	Sulfate in water containing calcium forms hard scale in steam boilers. In large amounts, sulfate in combination with other ions gives bitter taste to water. Some calcium sulfate is considered beneficial in the brewing process. U.S. Public Health Service (1962) drinking-water standards recommend that the sulfate content should not exceed 250 mg/l.
Chloride (Cl)	Dissolved from rocks and soils. Present in sewage and found in large amounts in ancient brines, sea water, and industrial brines.	In large amounts in combination with sodium, gives salty taste to drinking water. In large quantities, increases the corrosiveness of water. U.S. Public Health Service (1962) drinking-water standards recommend that the chloride content should not exceed 250 mg/l.
Fluoride (F)	Dissolved in small to minute quantities from most rocks and soils. Added to many waters by fluoridation of municipal supplies.	Fluoride in drinking water reduces the incidence of tooth decay when the water is consumed during the period of enamel calcification. However, it may cause mottling of the teeth, depending on the concentration of fluoride, the age of the child, amount of drinking water consumed, and susceptbility of the individual. (Maier, 1950)
Nitrate (NO_3)	Decaying organic matter, sewage, fertilizers, and nitrates in soil.	Concentration much greater than the local average may suggest pollution. U.S. Public Health Service (1962) drinking-water standards suggest a limit of 45 mg/l. Waters of high nitrate content have been reported to be the cause of methemoglobinemia (an often fatal disease in infants) and therefore should not be used in infant feeding. Nitrate has been shown to be helpful in reducing inter-crystalline cracking of boiler steel. It encourages growth of algae and other organisms which produce undesirable tastes and odors.
Dissolved solids	Chiefly mineral constituents dissolved from rocks and soils. Includes some water of crystallization.	U.S. Public Health Service (1962) drinking-water standards recommend that waters containing more than 500 mg/l dissolved solids not be used if other less mineralized supplies are available. Waters containing more than 1000 mg/l dissolved solids are unsuitable for many purposes.
Hardness as $CaCO_3$	In most waters nearly all the hardness is due to calcium and magnesium. All the metallic cations other than the alkali metals also cause hardness.	Consumes soap before a lather will form. Deposits soap curd on bathtubs. Hard water forms scale in boilers, water heaters, and pipes. Hardness equivalent to the bicarbonate and carbonate is called carbonate hardness. Any hardness in excess of this is called non-carbonate hardness. Waters of hardness as much as 60 ppm are considered soft; 61 to 120 mg/l, moderately hard; 121 to 180 mg/l, hard; more than 180 mg/l, very hard.
Specific conductance (micromhos at 25°C)	Mineral content of the water.	Indicates degree of mineralization. Specific conductance is a measure of the capacity of the water to conduct an electric current. Varies with concentration and degree of ionization of the constituents.
Hydrogen ion concentration (pH)	Acids, acid-generating salts, and free carbon dioxide lower the pH. Carbonates, bicarbonates, hydroxides, and phosphates, silicates, and borates raise the pH.	A pH of 7.0 indicates neutrality of a solution. Values higher than 7.0 denote increasing alkalinity; values lower than 7.0 indicate increasing acidity. pH is a measure of the activity of the hydrogen ions. Corrosiveness of water generally increases with decreasing pH. However, excessively alkaline waters may also attack metals.

Water from drilled wells in the Woodbine Formation and Nacatoch Sand generally contained a higher concentration of dissolved solids than water from other geologic units. The dissolved-solids content of all samples from the Woodbine exceeded 1,000 mg/l, and most samples from drilled wells in the Nacatoch contained more than 500 mg/l. Most of the highly mineralized (moderately to very saline) water in the Nacatoch is at depths greater than 300 feet. Water in association with crude oil from oil wells about 800 feet deep in the Nacatoch where faults are prominent contains as much as 21,000 mg/l of dissolved solids (Osborne and Shamburger, 1960, p. 57).

Water from shallow dug wells in the Wolfe City Sand Member commonly contained less than 500 mg/l of dissolved solids. Electric logs indicate that mineralization of water in the Wolfe City increases sharply downdip within a few hundred feet of land surface, and petroleum-associated water from the Wolfe City Sand Member from a depth of about 1,600 feet contains as much as about 41,000 mg/l dissolved solids (Osborne and Shamburger, 1960, p. 58).

Nearly half of the water samples collected from other geologic units contained less than 500 mg/l dissolved solids. Of the 52 percent containing more than 500 mg/l dissolved solids, only one contained more than 3,000 mg/l.

The sulfate concentration exceeded 250 mg/l in 39 of 164 samples. The maximum was 1,660 mg/l in a sample from well TY-39-05-501 in the Midway Group. Almost a third of the water samples with sulfate concentrations greater than 250 mg/l were from the Woodbine Formation.

Chloride content is not generally high in shallow ground water in Navarro County, but is high in the deep aquifers. Forty-three of 165 water samples contained more than 250 mg/l chloride. The chloride concentration ranged from 1.0 to 5,820 mg/l. The largest concentration occurred in well TY-33-59-301 and probably represents contamination of the Woodbine Formation by leakage through the well casing from the Wolfe City Sand Member.

The optimum fluoride level for a given area depends upon climatic conditions because the amount of drinking water consumed is influenced by the air temperature. Based on the annual average of the maximum daily temperature at Corsicana of 78°F (26°C) from 1931 to 1960, the optimum fluoride content in drinking water in Navarro County is 0.8 mg/l, and fluoride should not average more than 1.0 mg/l nor less than 0.7 mg/l. Fluoride concentrations greater than 1.6 mg/l (twice the optimum) constitute grounds for rejection of a public-water supply by the Public Health Service.

Of the 70 fluoride determinations (Table 8), 27 samples exceeded 1.0 mg/l, and 21 exceeded 1.6 mg/l. Fluoride in 43 percent of the samples was deficient in the desired concentration of 0.7 mg/l. In 17 of 19 water samples from the Woodbine Formation, the fluoride exceeded 1.6 mg/l. The maximum fluoride concentration was 6.1 mg/l in the Blooming Grove public-water supply well TY-33-59-102 tapping the Woodbine Formation.

The upper limit for nitrate concentration, according to the Public Health Service, is 45 mg/l. The use of water containing nitrate in excess of 45 mg/l has been related to infant cyanosis or "blue baby" disease (Maxcy, 1950, p. 271). The presence of more than several milligrams per liter of nitrate in water may indicate contamination by sewage or other organic matter (Lohr and Love, 1954, p. 10). Contamination is more likely in shallow dug wells than in deep wells.

Nitrate concentrations were high in some of the 96 samples analyzed (Table 8); 34 samples or 35 percent contained more than 45 mg/l. Twenty-six of the samples containing more than 45 mg/l were collected from shallow wells in the Midway Group and Taylor Marl. The slightly permeable clay soils of these weathered geologic units are extensively cultivated and are commonly fertilized during cultivation. Many of the sampled shallow wells are open at the surface and used infrequently. Residual fertilizers in poorly drained soils and accumulations of decomposed vegetable and animal matter probably contributed to the high nitrate content of water in the shallow dug wells of Navarro County. Two ground-water samples contained very high concentrations of nitrate. Water from a depth of 18 feet in well TY-33-60-804 tapping the Taylor Marl (exclusive of Wolfe City Sand Member) contained 2,190 mg/l; and water from a depth of 35 feet in well TY-33-59-502 tapping the Wolfe City Sand Member of the Taylor Marl contained 1,640 mg/l.

Hardness in water is caused principally by calcium and magnesium. Excessive hardness increases soap consumption and induces the formation of scale in hot water heaters and water pipes. Although no limits for hardness have been established by the Public Health Service, a commonly accepted classification is shown in Table 4.

The results of 164 analyses (Table 8) show that much of the ground water ranges from moderately hard (61-120 mg/l) to very hard (more than 180 mg/l). Hardness exceeded 60 mg/l in 130 samples and 180 mg/l in 90 samples. The hardness of about 49 percent of the samples ranged from 180 mg/l to 1,000 mg/l. Water from wells TY-33-60-804, which taps the Taylor Marl (exclusive of Wolfe City Sand Member), and TY-33-59-502, which taps the Wolfe City Sand Member, had a hardness of 3,120 mg/l and 2,260 mg/l, respectively. Eighteen of the 19 water samples from the Woodbine Formation were soft, and about 44 percent of water samples from the Nacatoch Sand were soft.

Iron concentrations were high in only one-third of the ground water sampled in Navarro County. Of the 35 determinations, 11 exceeded 0.3 mg/l, the limit above which iron staining may occur. All samples exceeding this limit came from either the Woodbine Formation or the Nacatoch Sand. The maximum concentration of iron was 5.8 mg/l in well TY-33-59-301 in the Woodbine.

Some of the chemical characteristics of water that are of particular importance in evaluating its use for irrigation are SAR (sodium adsorption ratio), specific conductance, RSC (residual sodium carbonate), and boron concentration. Generally, water is safe for supplemental irrigation, according to Wilcox (1955, p. 16) if its conductivity is less than 2,250 micromhos per centimeter at 25°C and its SAR is less than 14. If the specific conductance is less than 2,250, the allowable upper limit of SAR may be increased. Table 8 shows that of 58 samples of water having both SAR and specific conductance determinations, 35 were within the allowable upper limits. Water produced from the Woodbine Formation and most of the water from the Nacatoch Sand exceeds the recommended limit for specific conductance or SAR and is not suitable for sustained irrigation.

Some of the water is also unsuitable for irrigation because of the RSC content. Wilcox (1955, p. 11) reports that water containing more than 2.5 me/l (milliequivalents per liter) RSC is undesirable for irrigation; water containing 1.25 to 2.5 is marginal; and water containing less than 1.25 is probably safe. The RSC exceeded 2.5 me/l in 21 of 148 samples tested; 62 percent of these exceeding 2.5 me/l were taken from the Woodbine and the Nacatoch.

The boron content of water is also significant in the evaluation of irrigation water. Wilcox (1955, p. 11) suggests that a permissible boron concentration for water used in irrigating boron-sensitive crops can be as much as 1.0 mg/l, but for boron-tolerant crops it can be as much as 3.0 mg/l. Boron determinations were made for eight samples in Navarro County (Table 8). The boron content ranged from 0.34 mg/l in well TY-33-54-201 tapping the alluvium to 7.7 mg/l in well TY-39-04-401 tapping the Woodbine Formation.

The temperature of ground water may be an important consideration for certain industrial uses such as cooling. The mean annual air temperature at Corsicana of about 66.4°F (19.1°C) approximates the temperature of ground water near the land surface. The average temperature of ground water in shallow wells sampled in Navarro County was 19°C (67°F). Temperature data from water wells and oil tests in Ellis County indicate that the ground-water temperature increases about 1.5°F for every 100 feet of increase in depth. Data from water- and oil-test wells in Navarro County indicate a slightly higher rate of increasing temperature. In Navarro County, temperature increases about 1.7°F (nearly 1°C) for every 100 feet of increased depth to about 3,500 feet below land surface; the increase is about 1.2°F for every 100 feet of increase in depth between 3,000 and 8,000 feet below land surface. Therefore, in Navarro County, the temperature gradient of about 1.7°F (or 1°C) per 100 feet may be applied to the mean temperature base of 19°C (67°F) to determine the approximate temperature of water at any given depth down to about 3,500 feet.

Water samples from four wells were analyzed for nine insecticides and three herbicides. The wells selected for sampling were in areas where plants were cultivated and probably sprayed. The water samples were obtained from the following shallow water wells: TY-33-52-204, TY-33-58-702, TY-33-61-302, and TY-33-62-303. The water from well TY-33-52-204 sampled July 10, 1968, showed only a trace, less than 0.005 μg/l (micrograms per liter) of DDE. The water from well TY-33-58-702 was sampled at two different times. The first sample (July 2, 1968) showed 1.2 μg/l of toxaphene and a trace of lindane. The second sample (August 26, 1968) showed toxaphene (0.31 μg/l) and dieldrin (0.05 μg/l). The water from well TY-33-61-302 was sampled at two different times. The first sample (July 15, 1968) showed toxaphene (2.5 μg/l), and the second sample (August 26, 1968) showed DDE (0.01 μg/l) and DDT (0.03 μg/l). The fourth water well, TY-33-62-303, sampled July 23, 1968, showed three insecticides: DDE (0.02 μg/l), DDT (0.04 μg/l), and dieldrin (0.01 μg/l). According to the water quality criteria established by the National Technical Advisory Committee to the Secretary of the Interior (1968), the above insecticides are undesirable in any concentration, but the concentrations detected are within the established limits.

DISPOSAL OF SALT WATER AND POTENTIAL CONTAMINATION

According to a salt-water disposal inventory (Texas Water Commission and Texas Water Pollution Control Board, 1963), 25,421,185 barrels of salt water were produced in conjunction with the production of crude oil in Navarro County in 1961. The methods of disposal and the quantity disposed are shown in Table 5. The locations of the various oil fields are shown in Figure 8.

The open-surface pit and surface-water methods of disposal are the most hazardous with regard to contamination of fresh water at shallow depths. In 1961, 688,700 barrels of salt water were disposed in open-surface pits and 22,513,835 barrels were disposed in surface-water courses in Navarro County; this is a total of 23,202,535 barrels, which represent 91.3 percent of the total salt water produced in the county. In most oil fields throughout the State, surface pits for storing salt water are not lined with impervious materials that would prevent seepage of salt water into the fresh water-bearing sands. However, effective January 1, 1969, the Railroad Commission of Texas prohibited the use of pits for storage and evaporation of oilfield brine.

Table 5.—Methods of Disposal of Salt Water and Quantities Disposed, 1961

(From Texas Water Commission and Texas Water Pollution Control Board, 1963)

FIELD NAME	BRINE PRODUCTION (BARRELS)	BRINE DISPOSAL: INJECTION WELLS BARRELS	INJECTION WELLS PERCENT	OPEN-SURFACE PITS BARRELS	OPEN-SURFACE PITS PERCENT	SURFACE-WATER COURSES BARRELS	SURFACE-WATER COURSES PERCENT
Angus	No report						
Bazette	3,650	0	0	3,650	100	0	0
Carter-Gragg Pettit	0	0	0	0	0	0	0
Corsicana Shallow Wolfe City *	3,976,187	953,770	24	236,912	6	2,784,185	70
Currie	540,000	0	0	0	0	540,000	100
Great Western	25,550	18,050	70.6	7,500	29.4	0	0
Kerens-Woodbine	1,353,680	1,235,210	91.2	50,520	3.7	67,950	5.0
Nesbett-Woodbine	194,180	0	0	194,180	100	0	0
Powell	19,195,833	0	0	74,133	0.4	19,121,700	99.6
Reiter	11,400	10,300	90.4	1,100	9.6	0	0
Reka-6800 Feet	3,102	0	0	3,102	100	0	0
Reka	273	0	0	273	100	0	0
Richland	117,330	0	0	117,330	100	0	0
TOTALS	25,421,185 (*)	2,217,330	8.7	688,700	2.7	22,513,835	88.6

* Disposal method for 1,320 barrels unknown.

Although no chemical-quality data collected during this investigation indicated contamination of ground water by salt-water seepage from open-surface pits, part of this salt water may have penetrated the surface at some places and caused the local ground water to become saline.

The time required for salt water from disposal pits to affect the quality of water in nearby wells may vary considerably, depending upon the rate of movement of the salt water, which depends upon permeability and porosity of the rocks and the hydraulic gradient. The process may take several years or only a few months. Generally, contamination of the water is indicated by a large increase in the chloride content without an accompanying increase in the sulfate content. After a source of contamination is eliminated, a long period of natural leaching and dilution may be required to reduce contamination of the aquifer.

The most satisfactory method of disposal of salt water is through injection wells. In 1961, only 8.7 percent of the total quantity of salt water produced in Navarro County was disposed of by this method. Generally, salt water is injected into salt-water sands far below the base of the slightly saline water. The proper construction and operation of the injection wells are also important in assuring adequate protection of the fresh or slightly saline water.

The Oil and Gas Division of the Railroad Commission of Texas is responsible for regulations regarding the proper construction of oil wells. The Texas Water Development Board supplies data to oil operators and to the Railroad Commission so that all "fresh-water" strata may be protected. The term "fresh water" as used by the Railroad Commission may include water that is more mineralized than the "fresh to slightly saline water" as used in this report. An examination of the published field rules of the Railroad Commission showed that no field rules regarding surface-casing depths are specified by the Commission for any of the oil or gas fields in the county. However, the Woodbine and Nacatoch units in Navarro County may be locally contaminated by salt water from old improperly cased oil wells and oil tests drilled prior to regulation by the Railroad Commission.

Salt water from water-flooding of the Nacatoch Sand south of Corsicana may be encroaching on fresh to slightly saline water in the near-surface Nacatoch (depths less than 300 feet) that is tapped by drilled domestic wells between Corsicana and Richland. Property owners in this area reported that some private wells had become "salty", but water analyses of samples obtained during the present investigation showed no abnormal excesses of chloride.

AVAILABILITY OF GROUND WATER

The most favorable areas for development of ground water in Navarro County are those where the thicknesses of saturated sand containing fresh to slightly saline water are greatest. The approximate thicknesses of sand containing fresh to slightly saline water in the Hosston and Woodbine Formations are shown in Figures 9 and 10, respectively.

Figure 9 shows that the maximum saturated sand thickness in the Hosston Formation is in excess of 150 feet in a band extending northeastward from Blooming Grove and Barry into Ellis County. About 2.8 miles north of the town of Dawson in the southwestern part of the county, the thickness of saturated sand in the Hosston Formation is at least 132 feet. Assuming a well efficiency of 70 percent, an effectively constructed well in the Hosston could be expected to yield as much as 380 gpm with 250 feet of drawdown. In this case, the average saturated sand thickness would be 130 feet and the average transmissivity 6,500 gpd per foot.

Electric and drillers' logs indicate that the saturated sand containing fresh to slightly saline water in the Woodbine Formation varies considerably in thickness and is irregularly distributed areally. All fresh to slightly saline water occurs west-northwest of a boundary extending generally southwestward from Rice to Dawson. Figure 10 shows that the greatest thickness of saturated sands in the Woodbine Formation is 125 feet at Blooming Grove in the western part of Navarro County. In an area along the southwestern margin of the county, the thickness is at least 100 feet. The average thickness of the saturated sand is 76 feet. A well tapping the Woodbine could be expected to yield as much as 150 gpm with 250 feet drawdown, assuming a well efficiency of 70 percent.

The amount of water that can be pumped perennially in Navarro County without depleting the ground-water supply depends on several factors, one of the most important of which is the average effective rate of recharge. This can be estimated by determining the amount of water that originally moved through the aquifers, that is by determining the original transmission rate. However, this method is useful only if the hydraulic gradient before development can be determined. The water levels in wells tapping certain aquifers have declined substantially over a period of many years and apparently are still declining. The declines of water levels indicate that some aquifers in Navarro County have been affected by pumping within the county itself, and by pumping in Hill and Ellis Counties. The declines of water levels probably have increased both the hydraulic gradients and the quantities of water moving through the aquifers. Consequently, the original quantities of water transmitted are known to be less than at present.

Estimates of present transmission rates can be computed using the formula $Q = TIL$ in which Q is the quantity of water in gallons per day moving through the aquifer; T is the transmissivity of the aquifer in gallons per day per foot; I is the present hydraulic gradient of the potentiometric surface in feet per mile; and L is the length of the aquifer in miles normal to the hydraulic gradient.

Data are not available to determine accurately the present average hydraulic gradient in the Hosston Formation in Navarro County; however, sparse control points outside the county indicate that the present gradient is about seven feet per mile. Based on this gradient and an average transmissivity of about 6,500 gpd per foot, the present amount of water moving through the county in the Hosston is 1.4 mgd. As of 1968, the ground water moving through the Hosston Formation in Navarro County has not been tapped for development.

The available ground water in the Paluxy in Navarro County is small and is limited to the far western tip of the county as determined by the projection of the downdip limit of fresh to slightly saline water in Ellis County (Thompson, 1967, Figure 13). The quantity of water flowing in 1968 through the county in the Paluxy Sand was not determined but was estimated to be very small, chiefly because of a very small amount of saturated sand with a low hydraulic conductivity as indicated by electric logs.

An estimate of the quantity of water flowing through the county in the Woodbine Formation can be made in a similar manner to that made for the Hosston Formation. Based on an estimated present hydraulic gradient of about six feet per mile and an average transmissivity of about 2,300 gpd per foot, the quantity of water now flowing through the Woodbine in Navarro County is 0.4 mgd. About one-third of the water being transmitted through the aquifer is withdrawn by wells in Navarro County (Table 3). Any increase in ground-water development of the Woodbine to the west in Hill County and northwest in Ellis County would seriously reduce that which is available in Navarro County.

The specific quantity of water available from the Nacatoch Sand in central Navarro County is not known, but it is considerably less than that from the Woodbine Formation. Wells generally do not produce more than 10-15 gpm, and water quality deteriorates to moderately saline below depths of about 300 feet. The specific capacities of wells tested range from 0.09 to 0.33 gpm per foot.

Only small quantities of water are available from the Wilcox Group, Midway Group, Navarro Group (excluding Nacatoch Sand), and Taylor Marl. The shallow wells tapping these units yield water intermittently because their reliability depends upon the annual precipitation. The hydraulic conductivity of the units may increase locally where sand lenses occur at or near the land surface.

The quantity of water available from the flood-plain alluvium of the Trinity River and major streams within the county is not known; however, yields of properly constructed wells in the alluvium may be as much as 150 gpm.

Available data indicates that some aquifers in the area are transmitting water in excess of their rate of natural recharge. Consequently, any additional development of these aquifers will result in further lowering of the artesian head and in some aquifers, particularly in the Nacatoch Sand, may cause a dewatering of the sand. Even a moderate increase in withdrawals of water in the partially developed areas of the Woodbine Formation will ultimately have a measurable effect on the artesian head in the more heavily pumped areas in the county. Because the Hosston Formation is untapped in Navarro County and is still transmitting a large quantity of water, this aquifer is a valuable potential source of ground water for development. A sizeable development of water (1.4 mgd) from the Hosston can be accomplished by properly spaced wells in the western and northwestern part of Navarro County.

NEEDS FOR ADDITIONAL STUDIES

The availability of water for additional development from the major aquifers in Navarro County depends to a large extent on the future development in neighboring counties, especially in Hill and Ellis Counties. Because each county is only one part of a larger hydrologic unit, determinations of the availability of water actually should be made on a regional basis rather than on a county basis. The region should include at least Hill, Ellis, and McLennan Counties.

A program should be established in the region for the collection of basic hydrologic data. The program should include periodic measurements of water levels in a network of observation wells in the areas of development and in the areas of recharge. Records should be kept of the annual withdrawals of water from each aquifer, and a network of wells for the periodic collection of water samples should be established to observe any changes in the chemical quality of the water. Except for the untapped Hosston Formation, such a program could be established in Navarro County on the basis of the data collected during the present investigation. Detailed studies should be made in the adjoining counties to the west of Navarro County before an adequate program of observation can be established in these areas. Additional field evaluations of the alluvium are needed because supplemental irrigation from the alluvium is the major use of ground water in Navarro County.

DEFINITIONS OF TERMS

Many of these definitions have been selected from reports by: Meinzer (1923a), American Geological Institute (1960), Langbein and Iseri (1960), and Ferris and others (1962).

Acre-feet.—The volume of water required to cover 1 acre to a depth of 1 foot (43,560 cubic feet), or 325,851 gallons.

Acre-feet per year.—One acre-foot per year equals 892.13 gallons per day.

Alluvial deposits.—Sediments deposited by streams. Includes flood-plain deposits and stream-terrace deposits.

Aquiclude.—A formation which, although porous and capable of absorbing water very slowly, will not transmit water at a rate fast enough to furnish an appreciable supply to a well or spring; compare—water-bearing formation, or unit.

Aquifer.—(restricted use) A formation, group of formations, or part of a formation that is sufficiently permeable to yield water to wells readily; compare—water-bearing formation, or unit.

Aquifer test, pumping test.—The test consists of the measurement at specific intervals of the discharge and water level of the well being pumped and the water levels in nearby observation wells. Formulas have been developed to show the relationships of the yield of a well, the shape and extent of the cone of depression, and the properties of the aquifer such as the specific yield, hydraulic conductivity, transmissivity, and storage coefficient.

Artesian aquifer, confined aquifer.—Artesian (confined) water occurs where an aquifer is overlain by rock of lower permeability (for example, clay) that confines the water under pressure greater than atmospheric. The water level in an artesian well will rise above the top of the aquifer. The well may or may not flow.

Artesian well.—One in which the water level rises above the top of the aquifer, whether or not the water flows at the land surface.

Brine.—Water containing more than 35,000 mg/l (milligrams per liter) of dissolved solids.

Cone of depression.—Depression of the water table or potentiometric surface surrounding a discharging well, more-or-less the shape of an inverted cone.

Confining bed.—One which, because of its position and low permeability relative to that of the aquifer, keeps the water in the aquifer under artesian pressure.

Contact.—The place or surface where two different kinds of rock or geologic units come together, shown on geologic maps and sections.

Dip of rocks, attitude of beds.—The angle or amount of slope at which a bed is inclined from the horizontal; direction is also expressed (for example, 1 degree, southeast; or 90 feet per mile, southeast).

Drawdown.—The lowering of the water table or potentiometric surface caused by pumping (or artesian flow). The difference in feet between the static level and the pumping level.

Electrical log.—A graphic log showing the relation of the electrical properties of the rocks and their fluid contents penetrated in a well. The electrical properties are natural potentials and resistivities to induced electrical currents, some of which are modified by the presence of the drilling mud.

En echelon.—Parallel structural features that are offset like the edges of shingles on a roof when viewed from the side.

Evapotranspiration.—Water withdrawn by evaporation from a land area, a water surface, moist soil, or the water table; and the water consumed by transpiration of plants.

Facies.—The "aspect" exhibited by a geological unit of sedimentation, including mineral composition, type of bedding, fossil content, etc. (for example, sand facies). Sedimentary facies are areally segregated parts of any genetically related body of sedimentary deposits.

Fault.—A fracture or fracture zone in rock along which there has been displacement of the two sides relative to one another parallel to the fracture.

Formation.—A body of rock that is sufficiently homogeneous or distinctive to be regarded as a mappable unit, generally named from a locality where the formation is typical (for example, Taylor Marl, Hosston Formation, and Woodbine Formation).

Fresh water.—Water containing less than 1,000 mg/l (milligrams per liter) of dissolved solids.

Graben.—A block of rock, generally long compared to its width, that has been downthrown along faults relative to the rocks on either side.

Ground water.—Water below land surface that is in the zone of saturation from which wells, springs, and seeps are supplied.

Head, or hydrostatic pressure.—Artesian pressure measured at the land surface, reported in pounds per square inch or feet of water.

Hydraulic conductivity.—The capacity of an aquifer or water-bearing formation for transmitting water under hydrostatic pressure. The capacity to transmit water is measured in gallons per day per square foot.

Hydraulic gradient.—The slope of the water table or potentiometric surface, usually given in feet per mile.

Hydrologic cycle.—The complete cycle of phenomena through which water passes, commencing as atmospheric water vapor, passing into liquid or solid form as precipitation, thence along or into the ground, and finally again returning to the form of atmospheric water vapor by means of evaporation and transpiration.

Irrigation, supplemental.—The use of ground or surface water for irrigation in humid regions as a supplement to rainfall during dry periods. Not a primary source of moisture as in arid and semiarid regions.

Lignite.—A brownish-black coal in which the alteration of vegetal material has proceeded further than in peat, but not as far as subbituminous coal.

Lithology.—The description of rocks, usually from observation of hand specimen, or outcrop.

Marl.—A calcareous clay.

Milliequivalents per liter (me/l).—An expression of the concentration of chemical substances in terms of the reacting values of electrically charged particles, or ions, in solution. One me/l of a positively charged ion (for example, Na^{+}) will react with one me/l of a negatively charged ion (for example, Cl^{-}).

Milligrams per liter (mg/l).—One milligram per liter represents one milligram of solute to one liter of solution. For water containing less than 7,000 mg/l dissolved solids, 1 milligram per liter is equivalent to 1 part per million.

Million(s) gallons per day (mgd).—One mgd equals 3.07 acre-feet per day or 1,121 acre-feet per year.

Mineral.—Any chemical element or compound occurring naturally as a product of inorganic processes.

Moderately saline water.—Water containing from 3,000 to 10,000 mg/l of dissolved solids.

Outcrop.—That part of a rock layer which appears at the land surface. On an areal geologic map a formation or other stratigraphic unit is shown as an area of outcrop where exposed and where covered by alluvial deposits. (Contacts below the alluvial deposits are shown on map by dotted lines.)

Porosity.—The ratio of the aggregate volume of interstices (openings) in a rock or soil to its total volume, usually stated as a percentage.

Potentiometric surface.—An imaginary surface that everywhere coincides with the static level of the water in the aquifer. The surface to which the water from a given aquifer will rise under its full head.

Recharge of ground water.—The process by which water is absorbed and is added to the zone of saturation. Also used to designate the quantity of water that is added to the zone of saturation, usually given in acre-feet per year or in million gallons per day.

Resistivity (electrical log).—The resistance of the rocks and their fluid contents penetrated in a well to induced electrical currents. Permeable rocks containing fresh water have high resistivities.

Slightly saline water.—Water containing from 1,000 to 3,000 mg/l of dissolved solids.

Specific capacity.—The rate of yield of a well per unit of drawdown, usually expressed as gallons per minute per foot of drawdown. If the yield is 250 gpm and the drawdown is 10 feet, the specific capacity is 25 gpm/ft.

Specific yield.—The quantity of water that an aquifer will yield by gravity if it is first saturated and then allowed to drain; the ratio expressed in percentage of the volume of water drained to volume of the aquifer that is drained.

Storage.—The volume of water in an aquifer, usually given in acre-feet.

Storage coefficient.—The volume of water that an aquifer releases from or takes into storage per unit surface area of the aquifer per unit change in the component of head normal to that surface. Storage coefficients of artesian aquifers may range from about 0.00001 to 0.001; those of water-table aquifers may range from about 0.05 to 0.30.

Structural feature, geologic.—The result of the deformation or dislocation (for example, faulting) of the rocks in the earth's crust. In a structural basin, the rock layers dip toward the center or axis of the basin. The structural basin may or may not coincide with a topographic basin.

Surface water.—Water on the surface of the earth.

Transmissivity.—The rate of flow of water in gallons per day through a vertical strip of the aquifer one foot wide extending through the vertical thickness of the aquifer at hydraulic gradient of one foot per foot and at the prevailing temperature of the water. The transmissivity from a pumping test is reported for the part of the aquifer tapped by the well.

Transmission capacity of an aquifer.—The quantity of water that can be transmitted through a given width of an aquifer at a given hydraulic gradient, usually expressed in acre-feet per year or million gallons per day.

Transpiration.—The process by which water vapor escapes from a living plant, principally from the leaves, and enters the atmosphere.

Very saline water.—Water containing from 10,000 to 35,000 mg/l of dissolved solids.

Water-bearing formation, or unit.—A consolidated to unconsolidated formation that contains water in the intergranular spaces of porous media, or in joints, fractures, or cavities of non-porous media. The formation's hydraulic conductivity determines the abundance of water yielded to wells; hence, the water-bearing formation may be either an aquifer or an aquiclude. See aquifer and aquiclude.

Water level.—Depth to water, in feet below the land surface, where the water occurs under water-table conditions (or depth to the top of the saturated zone). Under artesian conditions the water level is a measure of the pressure of the aquifer, and the water level may be at, below, or above the land surface.

Water level, pumping.—The water level during pumping, measured in feet below the land surface.

Water level, static.—The water level in an unpumped or nonflowing well, measured in feet above or below the land surface or sea-level datum.

Water table.—The upper surface of a saturated zone except where the surface is formed by an impermeable body of rock.

Water-table aquifer (unconfined aquifer).—An aquifer in which the water is unconfined; the upper surface of the saturated zone is under atmospheric pressure only and the water is free to rise or fall in response to the changes in the volume of water in storage. A well penetrating an aquifer under water-table conditions becomes filled with water to the level of the water table.

Yield of a well.—The rate of discharge commonly expressed as gallons per minute, gallons per day, or gallons per hour. In this report, yields are classified as very small, less than 10 gpm (gallons per minute); small, 10-50 gpm; and moderate, 50-500 gpm.

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Table 6.--Records of Wells and Test Holes in Navarro County and Adjacent Areas

All wells are dug unless otherwise noted in remarks column.
Water level : Reported water levels given in feet; measured water levels given in feet and tenths.
Method of lift and type of power: B, bucket; C, cylinder; E, electrical; G, LP gas; H, hand; J, jet; N, none; P, piston; S, submersible; T, turbine; W, wind. Number indicates horsepower.r.
Use of water : D, domestic; Ind, Industrial; Irr, irrigation; P, public supply; S, stock; U, unused.
Water-bearing : Qal, Quaternary alluvium; Twi, Wilcox Group; Tm, Midway Group; Kn, Navarro Group (excluding Nacatoch Sand); Knn, Nacatoch Sand of the Navarro Group; Kta, Taylor Marl (excluding Wolfe City Sand Member); Ktaw, Wolfe City Sand Member of the Taylor Marl; Kwb, Woodbine Formation; Kh, Hosston Formation.

WELL	WELL OWNER OR NAME OF WELL	DRILLER	DATE COMPLETED	DEPTH OF WELL (FT)	CASING DIAMETER (IN)	CASING DEPTH (FT)	WATER-BEARING UNITS	ALTITUDE OF LAND SURFACE (FT)	WATER LEVEL ABOVE (+) OR BELOW LAND SURFACE DATUM (FT)	WATER LEVEL DATE OF MEASUREMENT	METHOD OF LIFT	USE OF WATER	REMARKS
							Navarro County						
* TY-33-45-602	J. R. Guynes	--	1910	25	30	--	Qal	325	19.5	Apr. 29, 1968	N	D,S	Open end.
* 901	L. B. Sands	--	Old	48	30	--	Knn	418	35.1	do.	J,E 1/2	D	Do.
46-401	T. Weaver	--	1963?	25	34	--	Qal	316	--	--	C,E 1/2	D	Do.
* 402	do.	--	1965?	22	34	--	Qal	311	8.6	Apr. 30, 1968	C,E 1/2	S	Do.
* 701	Edw. De Vance	--	1960	22	30	--	Qal	311	2.1	Apr. 26, 1968	J,E 1/2	S	Open end. Pump disconnected.
801	C. White	--	1957	27	20	--	Qal	304	12.2	Apr. 16, 1968	T,G	Irr	Cased to 50 ft. Gravel packed and perforated from 20 ft. to bottom. Well partly sanded in.
* 51-801	--	--	Old	26	44	--	Ktaw	522	16.8	May 15, 1968	N	D	Open hole. Rarely used.
* 802	F. Sutters	F. Sutters	--	16	39	--	Kta	420	4.3	do.	J,E 1/2	D	Open end. Never dry. Supplies several houses.
803	W. Armstrong	--	1955?	99	--	--	Kta	--	--	--	--	S	
* 901	--	--	Old	25	24	--	Ktaw	520	6.8	May 14, 1968	B,H	D	Open end.
* 902	--	--	Old	24'	26	--	Kta	502	6.9	July 3, 1968	C,E 1/3	D	Open end.
* 52-204	--	--	Old	31	32	--	Kta	450	22.4	July 10, 1968	N	S	Do.
* 401	R. Culcurt	--	1925?	35	28	--	Kta	431	21	May 14, 1968	N	S	Do.
* 501	J. Simmons	--	Old	34	32	--	Kta	418	19.8	Mar. 29, 1968	P,W	S	Do.
* 502	--	--	Old	35	32	--	Kta	418	27.8	July 9, 1968	N	S	Do.
* 701	Howell Bros.	Howell Bros.	1935	19	36	--	Kta	433	15.2	May 14, 1968	N	D	Do.
* 702	--	--	Old	19	24	--	Kta	456	6.4	July 9, 1968	N	S	Do.
* 801	H. R. Stroube	H. R. Stroube	1956	1,750	4	--	Kwb	473	300 412.7 435.8	1956 Aug. 26, 1965 Dec. 1, 1967	S,E 3	P	Drilled. Perforated from 1,700 to 1,750 ft. Reported discharge 7 gpm. 1/

See footnotes at end of table.

Table 6.--Records of Wells and Test Holes in Navarro County and Adjacent Areas--Continued

WELL	WELL OWNER OR NAME OF WELL	DRILLER	DATE COM-PLET-ED	DEPTH OF WELL (FT)	CASING DIAM-ETER (IN)	CASING DEPTH (FT)	WATER-BEAR-ING UNITS	ALTITUDE OF LAND SURFACE (FT)	WATER LEVEL ABOVE (+) OR BELOW LAND SURFACE DATUM (FT)	WATER LEVEL DATE OF MEASUREMENT	METHOD OF LIFT	USE OF WATER	REMARKS
							Navarro County						
* TY-33-52-802	City of Emhouse, Well 2	F. M. Allison	1917	2,017	6,4,3	--	Kwb	474	+25 0	Nov. 7, 1917 1925	N	U	Drilled. Flowed about 50,000 gpd when drilled. Stopped flowing in 1928. Destroyed few years prior to 1968. 2/
* 803	S. L. Wooten	--	1959	25	30	--	Kta	419	6.4	May 10, 1968	B,H	D	Open end. Never dry.
* 901	--	--	Old	38	30	--	Kn	401	19.1	July 4, 1968	N	S	Open end. Used occassionally.
* 53-101	--	--	Old	15	29	--	Kn	462	.7	Apr. 30, 1968	N	S	Open end. Rarely used.
* 102	--	--	Old	13	36	--	Kn	419	2.4	May 1, 1968	N	S	Open end. Well down slope from several old oil wells. Rarely used.
103	British American Oil Co., Clarkson Well 1	British American Oil Co.	1944	2,598	9	--	--	395	--	--	N	U	Oil test. 1/
* 201	--	--	Old	44	24	--	Knn	462	22.9	Apr. 30, 1968	N	D	Open end. Used periodically.
* 202	J. Arnett	--	Old	34	32	--	Knn	475	26.9	July 10, 1968	B,H	D	Open end. Never dry.
203	Stewart and Lewis, Hodge Est. Well 1	L. & S. Drilling Co.	1946	3,801	8	--	--	449	--	--	N	U	Oil test. 1/
301	Oakland Corp., L. P. Hodge Well 1	Oakland Corporation	1954	2,786	8	--	--	417	--	--	N	U	Oil test. 1/
* 401	R. G. Terrell	--	Old	16	36	--	Kn	372	.0	May 1, 1968	N	S	Open end. Near old oil wells. Rarely used.
402	Heinen & Garonzik, Fortson Well 1	Heinen & Garonzik	1938	3,631	8	--	--	345	--	--	N	U	Oil test. 1/
* 501	--	--	1962	39	30	--	Knn	416	23.2	July 11, 1968	J 1/2	D	Open end.
601	Bryant Cotton Co.	--	1924	200	4	--	Knn	431	--	--	N	U	Drilled. Perforated from 160 to 200 ft. Destroyed after 1961.
* 602	Roane Water Corp. Well 1	J. L. Myers' Sons	1962	253	4	--	Knn	427	91	July 11, 1962	S,E 2	P	Drilled. Screened from 224 to 249 ft. Reported discharge 10 gpm. 1/
* 603	Roane Water Corp. Well 2	do.	1962	259	4	--	Knn	426	95 105.6	Aug. 7, 1962 Feb. 7, 1968	S,E 2	P	Drilled. Gravel packed and screened from 230 to 255 ft. Reported discharge 12 gpm. 2/

See footnotes at end of table.

Table 6.--Records of Wells and Test Holes in Navarro County and Adjacent Areas--Continued

WELL	WELL OWNER OR NAME OF WELL	DRILLER	DATE COM-PLET-ED	DEPTH OF WELL (FT)	CASING DIAM-ETER (IN)	CASING DEPTH (FT)	WATER-BEAR-ING UNITS	ALTITUDE OF LAND SURFACE (FT)	WATER LEVEL ABOVE (+) OR BELOW LAND SURFACE DATUM (FT)	WATER LEVEL DATE OF MEASUREMENT	METHOD OF LIFT	USE OF WATER	REMARKS
							Navarro County						
* TY-33-53-604	--	--	Old	70	8	--	Kn	415	60	Apr. 23, 1968	P,W	S	Bored. Open end. Rarely used.
* 701	--Reamy (tenant)	--	1957	36	30	--	Knn	370	16.7	May 1, 1968	B,H	S	Open end.
* 801	E. T. Denn	--	Old	29	30	--	Knn	401	26.2	July 11, 1968	N	D	Open end. Near old oil well. Rarely used.
802	J. L. Collins Co., M. Williams Well 1	J. L. Collins Co.	1949	2,780	9	--	--	338	--	--	N	U	Oil test. 1/
54-101	C. White	--	1957	42	20	--	Qal	312	26.2	Apr. 16, 1968	T,G	Irr	
102	do.	--	1957	37	20	--	Qal	311	24.5	do.	T,G	Irr	
* 103	do.	--	1957	31	30	--	Qal	314	27.1	Apr. 17, 1968	J,E 1/2	D	Goes dry sometimes. Open end.
104	do.	--	1957	29	20	--	Qal	316	27.5	do.	T,G	Irr	
105	do.	--	1957	50	20	--	Qal	312	--	--	T,G	Irr	Gravel packed and perforated 20-50 ft.
106	do.	--	1957	50	20	--	Qal	314	--	--	T,G	Irr	Do.
107	do.	--	1957	50	20	--	Qal	307	--	--	T,G	Irr	Do.
* 201	C. W. White	--	1957	26	20	--	Qal	301	12.1	Apr. 12, 1968	T,E 5	Irr	Gravel packed and perforated 20-26 ft.
202	C. White	--	1957	28	20	--	Qal	300	9.9	Apr. 17, 1968	T,E 5	Irr	
203	do.	--	1957	50	20	--	Qal	308	--	--	T,G	Irr	Gravel packed and perforated 20-50 ft.
204	do.	--	1957	50	20	--	Qal	308	--	--	T,G	Irr	Do.
205	C. White	--	1957	50	20	--	Qal	304	--	--	S,E 5	Irr	Gravel packed and perforated 20-50 ft.
206	E. J. Moran	E. J. Moran	1945	3,225	--	--	Kwb	338	--	--	N	U	Oil test. 1/
* 301	Leroy Crocker	--	1935?	18	42	--	Twi	323	11.5	Apr. 12, 1968	C,G 2	S	Open end.
* 302	J. E. Hancock	--	1966	46	32	--	Twi	322	22.2	Apr. 16, 1968	J,E 1/2	D	Do.
* 401	J. A. Slaughter	--	Old	18	60	--	Kn	426	2.9	Apr. 23, 1968	B,H	D	
* 501	Tom Warren	Tom Warren	1917	16	44	--	Tm	432	.7	Apr. 11, 1968	N	S	

See footnotes at end of table.

Table 6.--Records of Wells and Test Holes in Navarro County and Adjacent Areas--Continued

WELL	WELL OWNER OR NAME OF WELL	DRILLER	DATE COMPLETED	DEPTH OF WELL (FT)	CASING: DIAMETER (IN)	CASING: DEPTH (FT)	WATER-BEARING UNITS	ALTITUDE OF LAND SURFACE (FT)	WATER LEVEL: ABOVE (+) OR BELOW LAND SURFACE DATUM (FT)	WATER LEVEL: DATE OF MEASUREMENT	METHOD OF LIFT	USE OF WATER	REMARKS
							Navarro County						
* TY-33-54-502	--	--	Old	19	30	--	Tm	374	9.3	Apr. 15, 1968	N	S	
601	J. W. Baldwin, Arnett Well 1	J. W. Baldwin	1955	4,003	8	--	--	425	--	--	N	U	Oil test. 1/
* 602	W. Creagean	--	1955?	38	30	--	Tm	414	11.1	Apr. 11, 1968	B,H	D	
603	L. T. Davis, Wilson Well 1	L. T. Davis	1944	3,520	8	--	--	392	--	--	N	U	Oil test. 1/
701	--	--	1947	29	30	--	Kn	412	24.8	Apr. 15, 1968	B,H	D	
* 702	--	--	1957	28	30	--	Kn	391	6.3	Apr. 18, 1968	N	D	
* 703	--	--	Old	31	32	--	Kn	423	29.9	do.	N	D	
801	J. L. Collins & Co. Barnett Well 1	J. L. Collins & Co.	1947	6,504	11,8	--	--	375	--	--	N	U	Oil test. 1/
802	--	--	Old	25	30	--	Tm	359	5.8	Apr. 9, 1968	N	U	Unused.
* 803	--	--	Old	36	38	--	Tm	393	19.5	do.	B,H	S	
* 804	N. Grocher	--	Old	31	34	--	Tm	381	20.0	Apr. 18, 1968	B,H	D	
805	L. T. Davis, Walker Well 1	L. T. Davis	1942	3,260	9	--	--	368	--	--	N	U	Oil test. 1/
* 55-101	J. E. Hancock	--	1966	31	32	--	Twi	313	7.5	Apr. 16, 1968	J,E 1/2	D	Near stock tank.
* 401	--	--	Old	20	54	--	Tm	393	5.6	Apr. 10, 1968	B,H	D	Used occasionally.
* 402	S. M. Huggins	--	1900?	26	36	--	Tm	395	2.8	Apr. 10, 1968	B,H	D	Never dry.
* 403	--	--	Old	30	30	--	Tm	415	22.7	Apr. 11, 1968	N	S	
* 501	--	--	Old	15	28	--	Twi	402	9.4	Apr. 10, 1968	N	U	Unused.
502	J. O. Griffith, Haynes Well 1	J. O. Griffith	1938	3,492	10	--	--	359	--	--	N	U	Oil test.
* 701	G. J. McDowell	--	1900?	34	22	--	Tm	393	15.7	Apr. 9, 1968	J,E 1/2	D	
* 702	W. Scarbrough	P. Hampton	1964	61	30	--	Tm	356	26.8	July 11, 1968	J,E 1	D	Used for lawn.
* 801	C. C. Bichell	--	--	23	36	--	Twi	348	2.1	Feb. 16, 1968	D	U	Unused.

See footnotes at end of table.

Table 6.--Records of Wells and Test Holes in Navarro County and Adjacent Areas--Continued

WELL	WELL OWNER OR NAME OF WELL	DRILLER	DATE COM-PLET-ED	DEPTH OF WELL (FT)	CASING DIAM-ETER (IN)	CASING DEPTH (FT)	WATER-BEAR-ING UNITS	ALTITUDE OF LAND SURFACE (FT)	WATER LEVEL ABOVE (+) OR BELOW LAND SURFACE DATUM (FT)	WATER LEVEL DATE OF MEASUREMENT	METHOD OF LIFT	USE OF WATER	REMARKS
							Navarro County						
TY-33-55-802	Ryan Consolidated Petroleum Corp., Redford Well 1	Ryan Consolidated Petroleum Corp.	1944	3,600	8	--	--	355	--	--	N	U	Oil test. 1/
901	--	--	--	22	30	--	Twi	305	9.4	Feb. 27, 1968	N	U	Unused.
* 902	--	--	--	44	30	--	Twi	325	34.9	do.	J,E	U	
58-401	C. Williams	--	--	900±	4	--	Kwb	541	50.4	June 11, 1968	P,N	U	Drilled. Pump broken. Unused.
* 501	City of Frost, Well 1	C. L. Witherspoon	1890?	1,184	6	--	Kwb	545	150	1961	T,E 25	P	Drilled. Cased to bottom. Lower part perforated. Reported discharge 65 gpm. Pump set 465 ft.
* 502	Williams and Griffis Gins	--	1960	1,290	6,4	--	Kwb	520	345.6	July 18, 1968	S,E 3	Ind	Drilled. Supplies cotton gin.
601	F. W. Wilson, Sheppard Well 1	--	1944	2,511	8	--	--	545	--	--	N	U	Oil test. 1/
* 602	--	--	Old	18	32	--	Kta	537	2.1	June 6, 1968	N	S	Brick wall. Open end.
* 701	J. C. Fly	--	1910?	1,100±	4	--	Kwb	528	250	1967	P,E 1 1/2	D	Drilled.
* 702	--	--	1960?	16	34	--	Kta	521	5.3	Aug. 26, 1968	C,E 1/3	D	Concrete lined. Open end.
* 801	--	--	Old	20	60	--	Kta	539	8.3	June 5, 1968	N	S	Unused. Open end.
* 59-101	City of Blooming Grove, Well 1	H. R. Dearing & Sons	1925	1,488	6,5	--	Kwb	595	275	1968	T,E 20	P	Drilled. Cased to bottom. Perforated 1,401-1,450 ft. Reported discharge 65 gpm.
* 102	City of Blooming Grove, Well 2	John Allen (J. L. Myers' Sons)	1966	1,603	8,4	--	Kwb	600	474.69	Feb. 13, 1968	S,E 40	P	Drilled. Gravel packed and screened 1,402-1,514 ft. Reported discharge 140 gpm. 1/ 2/
103	City of Blooming Grove, Well 3	Benton & Gaines	1907	1,436	6,3	--	Kwb	595	55 241.55	July 9, 1907 Feb. 22, 1944	T,E	U	Drilled. Disconnected pump.
* 104	--	--	--	20	36	--	Ktaw	620	18.2	May 15, 1968	N	D	
* 105	--	--	1958	6	30	--	Ktaw	593	.9	do.	J,E 1/2	D	Concrete lined. Open end.
* 201	--	--	1935?	34	36	--	Ktaw	540	23.7	May 16, 1968	N	S	Brick lined to 22 ft.
* 202	J. T. Bryant, Well 1	--	1900?	26	32	--	Ktaw	575	20.8	July 3, 1968	C,E 1/2	D,S	Brick lined to 14 ft. Abundance of water.

See footnotes at end of table.

Table 6.--Records of Wells and Test Holes in Navarro County and Adjacent Areas--Continued

WELL	WELL OWNER OR NAME OF WELL	DRILLER	DATE COMPLETED	DEPTH OF WELL (FT)	CASING: DIAMETER (IN)	CASING: DEPTH (FT)	WATER-BEARING UNITS	ALTITUDE OF LAND SURFACE (FT)	WATER LEVEL: ABOVE (+) OR BELOW LAND SURFACE DATUM (FT)	WATER LEVEL: DATE OF MEASUREMENT	METHOD OF LIFT	USE OF WATER	REMARKS
Navarro County													
* TY-33-59-203	J. T. Bryant, Well 2	--	1952	22	31	--	Ktaw	553	13.5	July 3, 1968	B,H	S	Concrete lined. Open end.
* 301	City of Barry, Well 2	H. R. Stroube, Jr.	1958	1,650	6,4	--	Kwb	503	176.9	Jan. 26, 1968	S,E	U	Drilled. Perforated 1,610-1,650 ft. Oil on top of water. Became salt contaminated, and now unused.
* 302	Barry Deep Well Co., Well 1	F. M. Allison	1917	1,721	4,3	--	Kwb	503	18 50-60 383.69	Sept. 20, 1917 1943 Jan. 30, 1968	N	U	Drilled. Screened from 1,572 to 1,625 ft. and 1,711 to 1,721 ft. Unused. 2/
* 303	--	--	--	18	27	--	Ktaw	518	3.6	May 15, 1968	N	S	Brick lined. Open end. Used occasionally.
* 401	--	--	Old	37	35	--	Ktaw	563	17.1	June 11, 1968	J,E 1/2	S	Brick lined to 12 ft.
501	M. Cannon Johnson Well 1	M. Cannon	1957	1,427	6	--	--	545	--	--	N	U	Oil test. 1/
* 502	B. & A. McCormick	--	Old	35	38	--	Ktaw	545	16.8	June 5, 1968	B,H	S	Brick lined to 12.5 ft.
* 701	do.	--	Old	19	36	--	Ktaw	505	2.8	June 7, 1968	N	S	Open end.
* 801	D. Melton	D. Melton	1956	24	25	--	Kta	517	4.4	May 17, 1968	N	D	Open end. Rarely used.
* 60-202	Corsicana Water Dept., Davis Well 2	Corsicana Water Department	1952	2,029	9	--	Kwb	452	190	Feb. 16, 1952	N	U	Drilled. Drill stem test from 1,835 to 1,980 ft. 1/
301	Brown & Wheeler, Drane Well 1	Brown & Wheeler	1954	2,505	8	--	--	436	--	--	N	U	Oil test. 1/
* 401	--	--	1935?	17	70	--	Kta	448	7.8	May 16, 1968	N	--	Brick lined. Open end.
* 501	--	--	1935?	11	60	--	Kn	461	3.0	May 17, 1968	N	S	Brick lined. Open end. Rarely used.
601	H. L. Hunt, Hamilton Well 1	H. L. Hunt	--	6,671	--	--	--	452	--	--	N	U	Oil test. 1/
* 701	--	--	1935?	17	60	--	Kta	444	.5	May 17, 1968	N	S	Brick lined. Open end. Rarely used.
702	Benz Oil Company, Baker Well 1	Benz Oil Company	1963	5,371	7	--	--	422	--	--	N	U	Oil test. 1/
* 801	C. Phillips, Well 1	Bailey Bros.	1962	26	30	--	Kn	409	4.2	May 16, 1968	J,E 1/2	D	Concrete lined. Open end.
802	C. Phillips, Well 2	Bailey Bros.	1962	36	30	--	Kn	412	6.0	do.	J,E 1/2	D	Concrete lined to bottom.

See footnotes at end of table.

Table 6.--Records of Wells and Test Holes in Navarro County and Adjacent Areas--Continued

WELL	WELL OWNER OR NAME OF WELL	DRILLER	DATE COM-PLET-ED	DEPTH OF WELL (FT)	CASING DIAM-ETER (IN)	CASING DEPTH (FT)	WATER-BEAR-ING UNITS	ALTITUDE OF LAND SURFACE (FT)	WATER LEVEL ABOVE (+) OR BELOW LAND SURFACE DATUM (FT)	WATER LEVEL DATE OF MEASUREMENT	METHOD OF LIFT	USE OF WATER	REMARKS
							Navarro County						
* TY-33-60-803	--	--	1930?	11	60	--	Kta	426	2.6	May 16, 1968	N	S	Open end. Rarely used.
* 804	--	--	1930?	18	60	--	Kta	434	16.3	do.	N	U	Possible pollution. Unused.
* 901	Mrs. N. Watts	--	Old	26	29	--	Knn	414	4.5	May 23, 1968	B,H	D	Brick lined to bottom.
61-101	City of Corsicana, Well 1	--	1894	1,035	4	--	--	422	0	July 18, 1968	N	U	Drilled for water test, struck oil, was first oil well west of Mississippi River. Still seeping oil in 1968.
* 102	City of Corsicana, Well 5	H. G. Johnson	1895	2,515	10	--	Kwb	418	82	May 19, 1938	N	U	Well destroyed about 1948. 2/
201	W. E. Butler, Roberts Well 1-w	W. E. Butler	1949	2,592	8	--	--	400	--	--	N	U	Oil test. 1/
* 301	--	--	Old	35	26	--	Kn	372	30.4	July 11, 1968	N	S	Brick lined. Open end.
* 302	F. Cartlidge	--	1965	23	30	--	Kn	372	11.1	July 15, 1968	J,E 1/2	D,S	Bored. Concrete lined. Open end. Caved from 23 to 32 ft. Abundant supply.
* 401	J. D. McManus	D. Donahue	1949	127	6	--	Knn	455	40.4	May 21, 1968	S,E 1/2	D	Drilled and cased to bottom. Perforated 117-127 ft.
* 402	B. Carpenter	--	1968	181	4	--	Knn	462	60.9	May 30, 1968	S,E 1	D	Drilled. Cased to 162 ft. Reported discharge 12 gpm.
* 701	--	--	Old	48	26	--	Kn	430	39.1	May 21, 1968	J,E 1/3	S	Brick lined. Open end.
* 702	F. E. Knotts	B. R. Martin	1963	241	5	--	Knn	451	69.8	June 13, 1968	S,E 1/2	D	Drilled. Cased to 208 ft. Open 208-241 ft.
801	Tex-Harvey Oil Co., Gillespie Well 27	Tex-Harvey Co.	1954	1,462	6	--	--	41	--	--	N	U	Oil test. 1/
802	Tex-Harvey Oil Co., Gillespie Well 22	do.	1953	1,419	6	--	--	410	--	--	N	U	Do. 1/
803	Tex-Harvey Oil Co., Gillespie Well 21	do.	1953	1,424	--	--	--	405	--	--	N	U	Do. 1/
* 804	--	--	Old	22	36	--	Kn	433	10.9	May 21, 1968	N	S	Brick lined.
901	J. Olson, Hill Well A-1	J. Olson	1954	3,242	8	--	--	431	--	--	N	U	Oil test. 1/
903	J. E. Whitten	--	1955	31	30	--	Tm	444	21.3	Apr. 4, 1968	J,E 1	D	Concrete lined. Open end. Never dry.

See footnotes at end of table.

Table 6.--Records of Wells and Test Holes in Navarro County and Adjacent Areas--Continued

WELL	WELL OWNER OR NAME OF WELL	DRILLER	DATE COM-PLET-ED	DEPTH OF WELL (FT)	CASING DIAM-ETER (IN)	CASING DEPTH (FT)	WATER-BEAR-ING UNITS	ALTITUDE OF LAND SURFACE (FT)	WATER LEVEL ABOVE (+) OR BELOW LAND SURFACE DATUM (FT)	WATER LEVEL DATE OF MEASUREMENT	METHOD OF LIFT	USE OF WATER	REMARKS
							Navarro County						
* TY-33-61-904	Monarch Oil Company	--	1960?	32	30	--	Tm	410	7.9	July 16, 1968	N	S	Concrete lined.
62-101	Chambers Creek Syndicate Brazelton Well 1	Chambers Creek Syndicate	1953	930	--	--	--	310	--	--	--	U	Oil test. 1/
* 102	A. G. Lockhart	--	Old	28	29	--	Tm	360	18.1	July 12, 1968	J,E 1	D	Brick lined. Abundant water reported. Near oil wells.
* 103	Mitchim Appliance	--	Old	23	41	--	Tm	365	19.8	July 15, 1968	N	S	Brick lined.
* 201	H. Ray	--	1950?	37	31	--	Tm	353	25.3	Mar. 27, 1968	J,E 1/2	D	Brick lined. Oil well 40 ft. south.
* 202	J. L. Aven	--	Old	16	30	--	Tm	326	6.1	do.	N	S	Brick lined.
* 203	--	--	1957	25	30	--	Tm	364	11.4	do.	N	S	Concrete lined.
301	C. Andrade & N. Ordnance, Cunningham Well 1	C. Andrade and North Ordnance	1944	4,000	8	--	--	358	--	--	N	U	Oil test. 1/
* 302	W. S. Price	--	1959	39	30	--	Tm	366	19.5	Apr. 5, 1968	J,E 1/2	D	Bored. Reported discharge 10 gpm. Concrete lined.
* 303	B. M. Kent	--	Old	34	30	--	Tm	364	20.8	July 17, 1968	J,E 1/3	S	Brick lined. Abundant water reported.
* 501	Floyd Nutt	--	1935?	20	34	--	Tm	355	6.7	May 3, 1968	B,H	U	Household drain near well. Well no longer used. Sometimes dry.
* 601	--	--	Old	34	31	--	Tm	354	14.1	July 17, 1968	N	S	Brick lined to bottom. Rarely used.
701	--	--	Old	16	32	--	Tm	417	14.9	Apr. 24, 1968	N	U	Partly caved. Unused.
* 702	W. Nelson	--	Old	24	26	--	Tm	403	23.4	July 16, 1968	N	U	Unused.
801	Fullwood & Thornton, Boyd Well 1	Fullwood & Thornton	1948	1,714	8	--	--	365	--	--	N	U	Oil test. 1/
* 802	--	--	Very old	26	24	--	Tm	415	14.9	July 17, 1968	N	S	Brick lined to bottom.
901	Intex Oil Company, Penny Well 1	Intex Oil Company	1952	3,308	8	--	--	321	--	--	N	U	Oil test. 1/
* 902	A. H. Hodge	--Barlow	1963	32	30	--	Tm	348	17.1	Apr. 5, 1968	C,E 2/3	D	Well augered and concrete lined. Never dry.

See footnotes at end of table.

Table 6.--Records of Wells and Test Holes in Navarro County and Adjacent Areas--Continued

WELL	WELL OWNER OR NAME OF WELL	DRILLER	DATE COM-PLET-ED	DEPTH OF WELL (FT)	CASING DIAM-ETER (IN)	CASING DEPTH (FT)	WATER-BEAR-ING UNITS	ALTITUDE OF LAND SURFACE (FT)	WATER LEVEL ABOVE (+) OR BELOW LAND SURFACE DATUM (FT)	WATER LEVEL DATE OF MEASUREMENT	METHOD OF LIFT	USE OF WATER	REMARKS
							Navarro County						
* TY-33-62-903	Gene Christie	C. Angland	1960	39	30	--	Tm	390	32.1	Apr. 5, 1968	N	D	Bored and concrete lined to bottom. Rarely used.
* 63-101	M. L. Quinn	--	1956	33	30	--	Tm	351	10.5	Mar. 22, 1968	J,E 1/2	D	Augered and concrete lined to bottom.
201	--	--	--	22	36	--	Tm	310	10.9	Feb. 20, 1968	N	U	Brick lined.
* 202	Mrs. Hightower	--	1925	48	30	--	Tm	341	24.7	Mar. 28, 1968	B,H	D	
* 501	--McQuary	--	1940	30	34	--	Tm	357	12.7	Mar. 22, 1968	J,E 1/2	D	Brick lined.
601	W. C. Perryman et al, Morris Well 1	--Perryman	1961	4,440	7	--	--	342	--	--	--	--	Oil test. 1/
602	--	--	Old	38	36	--	Tm	339	37.0	Mar. 28, 1968	N	U	Brick lined. Unused.
* 603	--	--	1957	54	30	--	Tm	343	44.4	do.	J,E 1/2	D	Concrete lined to bottom.
701	Gibson Drilling Co., Goldberg Well 1	Gibson Drilling Co.	1958	3,465	8	--	--	279	--	--	--	--	Oil test. 1/
702	Collins & Company, Greenlee Well 1	Collins & Co.	1945	7,507	8	--	--	342	--	--	--	--	Oil test. 1/
801	Carter Jones Drilling, Stockton Well 1	Carter Jones Drilling	1955	3,427	8	--	--	283	--	--	--	--	Oil test. 1/
802	Brown & Wheeler, Henderson Well 1	Brown & Wheeler	1951	7,232	8	--	--	294	--	--	--	--	Oil test. 1/
* 803	Marvin Henderson	--	1955	56	34	--	Tm	336	48.2	Mar. 25, 1968	J,E 1/2	S	Brick lined.
* 901	Mable Bryant	--	1935	58	36	--	Twi	327	49.4	Mar. 18, 1968	J,E 1/2	D	Brick lined to bottom. Never goes dry.
64-701	W. T. Ware Estate	--	Old	84	38	--	Twi	334	64.6	Mar. 28, 1968	T,E 2/3	U	Brick lined to bottom. Unused several years.
* 702	--	--	Old	31	34	--	Twi	300	27.1	Mar. 29, 1968	J,E 1/2	D	Brick lined to bottom. Well not used recently.
* 703	--	--	Old	24	32	--	Twi	284	8.6	do.	P,H	S	

See footnotes at end of table.

Table 6.--Records of Wells and Test Holes in Navarro County and Adjacent Areas--Continued

WELL	WELL OWNER OR NAME OF WELL	DRILLER	DATE COM-PLET-ED	DEPTH OF WELL (FT)	CASING DIAM-ETER (IN)	CASING DEPTH (FT)	WATER-BEAR-ING UNITS	ALTITUDE OF LAND SURFACE (FT)	WATER LEVEL ABOVE (+) OR BELOW LAND SURFACE DATUM (FT)	WATER LEVEL DATE OF MEASUREMENT	METHOD OF LIFT	USE OF WATER	REMARKS
							Navarro County						
TY-33-64-704	Hoxey Oil Company, Sheppard Well 1	Hoxey Oil Company	1955	8,042	--	--	--	268	--	Mar. 29, 1968	--	--	Oil test. 1/
39-02-202	J. K. Wadley, Cook Well 1	J. K. Wadley	1958	2,773	9	--	--	507	--	--	--	--	Oil test.
* 203	Pelham School District	--	1958	37	30	--	Kta	485	17.7	July 3, 1968	N	P	Concrete lined to bottom. Pump removed recently.
* 301	--	--	Old	32	36	--	Kta	471	23.6	do.	N	S	Brick lined. Rarely used.
* 302	--	--	Old	36	36	--	Ktaw	472	23.1	July 5, 1968	J,E 1/2	D	Brick lined to bottom.
501	Dobbson & Hoxsey, Cook Well 1	Dobbson & Hoxsey	1953	3,344	--	--	--	483	--	--	--	--	Oil test. 1/
* 901	--	--	Old	15	28	--	Ktaw	539	3.7	June 14, 1968	N	S	Brick lined to bottom.
* 03-101	--	--	Old	16	35	--	Ktaw	497	5.7	June 3, 1968	N	S	Rarely used.
* 301	State of Texas	--	Old	14	33	--	Kta	470	4.6	July 5, 1968	B,H	D	Used by Texas Highway Department.
401	Falcon Co. Keitt Well 1	Falcon Co.	1942	6,455	9	--	--	462	--	--	--	--	Oil test. 1/
* 402	--	--	Old	20	30	--	Ktaw	433	3.7	June 4, 1968	B,H	S	Brick lined to bottom.
* 501	--	--	1960	25	30	--	Kta	431	18.4	do.	C,E 1/3	S	Concrete lined to bottom.
* 601	--	--	1958	27	30	--	Qal	376	4.1	May 24, 1968	B,H	D	Concrete lined to bottom.
* 701	--	--	Old	18	40	--	Ktaw	492	5.6	June 4, 1968	N	D	Rarely used.
* 04-201	Leonard Ward	--	Old	30	31	--	Kta	416	4.6	May 24, 1968	C,E 1/3	S	Brick lined to bottom.
* 401	H. R. Stroube for City of Purdon, Well 1	H. R. Stroube	1956	1,750	8	--	Kwb	396	282.2 364.6	June 29, 1961 May 8, 1968	S,E 3	P	Drilled and cased to bottom. Perforated 1,700-1,740 ft. Reported discharge 7 gpm. Pump pulled permanently 8-15-68.
* 501	--	--	1915	43	35	--	Kn	412	34.9	May 29, 1968	N	S	Brick lined. Rarely used.
* 601	H. R. Stroube, Richland City, Well 1	H. R. Stroube	1958	120	7	--	Knn	336	11 44.9	July 5, 1961 May 9, 1968	S,E 1/2	P	Gravel packed and perforated 100-120 ft. Reported discharge 5 gpm.
602	H. R. Stroube, Richland City, Well 2	do.	1958	120	5	--	Knn	336	11 36.9	July 5, 1961 July 9, 1968	S,E 1/2	P	Gravel packed and perforated 100-120 ft.

See footnotes at end of table.

Table 6.--Records of Wells and Test Holes in Navarro County and Adjacent Areas--Continued

WELL	WELL OWNER OR NAME OF WELL	DRILLER	DATE COMPLETED	DEPTH OF WELL (FT)	CASING: DIAMETER (IN)	CASING: DEPTH (FT)	WATER-BEARING UNITS	ALTITUDE OF LAND SURFACE (FT)	WATER LEVEL: ABOVE (+) OR BELOW LAND SURFACE DATUM (FT)	WATER LEVEL: DATE OF MEASUREMENT	METHOD OF LIFT	USE OF WATER	REMARKS
							Navarro County						
TY-39-04-603	H. R. Stroube, Richland City, Well 3	H. R. Stroube	1958	119	6	--	Knn	337	11	July 5, 1961	S,E 1/2	P	Gravel packed and perforated 100-120 ft. Reported discharge 5 gpm.
* 604	H. R. Stroube, Richland City, Well 4	do.	1958	120	4	--	Knn	336	11.9 19.1	July 5, 1961 May 9, 1968	S,E 1/2	P	Do.
605	H. R. Stroube, Richland City, Well 5	do.	1958	119	4	--	Knn	337	11 32.4	July 5, 1961 May 9, 1968	S,E 1/2	P	Do.
607	H. R. Stroube, Richland City, Well 7	do.	?	119	4	--	Knn	337	36.5	May 9, 1968	S,E 1/2	P	Gravel packed and perforated 100-120 ft.
608	H. R. Stroube, Richland City, Well 8	do.	?	119	4	--	Knn	338	18.5	May 4, 1968	S,E 1/2	P	Do.
* 609	--	--	Old	39	24	--	Knn	411	28.6	May 30, 1968	J,E 1/3	D	Brick lined to 18 ft.
* 801	--	--	Old	40	40	--	Kn	410	31.1	May 28, 1968	N	D	Brick lined.
05-101	Lee Hicks, West Well 2	Lee Hicks	1956	1,441	--	--	--	367	--	--	--	--	Oil test. 1/
* 102	--Watson	--	1917	28	26	--	Kn	340	10.1	May 20, 1968	N	S	Open end. Rarely used.
* 103	A. L. Weeks	--Bully	1968	77	6	--	Knn	392	35 35	Feb. 1968 May 23, 1968	J,E 1/2	D	Drilled and cased to bottom with open end.
* 104	C. J. Davis	--	1925	70	60	--	Knn	383	31.5	do.	J,E 1 1/2	D	Brick lined to bottom. Never dry.
301	Sohio & J. Bunn Cheney Well 1	Sohio & J. Bunn	1944?	3,141	8	--	--	361	--	--	--	--	Oil test. 1/
302	Coffield & Guthrie, Kelly Well 3	Coffield & Guthrie	1950	3,361	8	--	--	369	--	--	--	--	Oil test. 1/
303	Wheelock Oil Company, Bottoms Well 1	Wheelock Oil Company	1964	3,572	8	--	--	371	--	--	--	--	Oil test. 1/
* 304	--	--	Old	24	36	--	Tm	380	3.4	Apr. 25, 1968	N	S	Brick lined to bottom. Rarely used.
* 401	--Stroube	--	Old	16	30	--	Tm	385	2.2	June 13, 1968	P,H	D	Brick lined to bottom.
* 501	--	--	1935	42	38	--	Tm	365	28.8	May 3, 1968	N	D	Do.

See footnotes at end of table.

Table 6.--Records of Wells and Test Holes in Navarro County and Adjacent Areas--Continued

WELL	WELL OWNER OR NAME OF WELL	DRILLER	DATE COM-PLET-ED	DEPTH OF WELL (FT)	CASING DIAM-ETER (IN)	CASING DEPTH (FT)	WATER-BEAR-ING UNITS	ALTITUDE OF LAND SURFACE (FT)	WATER LEVEL ABOVE (+) OR BELOW LAND SURFACE DATUM (FT)	WATER LEVEL DATE OF MEASUREMENT	METHOD OF LIFT	USE OF WATER	REMARKS
							Navarro County						
* TY-39-05-502	Clyde Anglin	--	1935	33	40	--	Tm	340	21.3	May 3, 1968	N	D	Brick lined to bottom.
601	C. L. Brown, Brown Well 1	C. L. Brown	1940	3,004	--	--	--	346	--	--	--	--	Oil test. 1/
701	F. R. Jackson, Bounds Well 1	F. R. Jackson	1954	1,012	8	--	--	415	--	--	--	--	Oil test. 1/
702	Coats & Danciger, Ross Well 1	Coats & Danciger	1949	3,421	8	--	--	425	--	--	--	--	Oil test. 1/
* 703	--	--	Old	24	29	--	Tm	422	1.1	May 16, 1968	P,H	S	Brick lined to bottom.
* 704	--	--	Old	26	44	--	Tm	490	3.7	June 13, 1968	J,E 1/2	D	Well open. Wall 2.6 ft. to bottom.
801	Vanson Production Corp. B. Elkins Well 1	Vanson Production Corp.	1957	3,525	8	--	--	362	--	--	--	--	Oil test. 1/
802	Humble Oil, S. Richland Well 1	Humble Oil	1965	3,665	8	--	--	361	--	--	--	--	Oil test. 1/
901	Intex Oil Co., Adams Well 1	Intex Oil Co.	1949	3,112	8	--	--	415	--	--	--	--	Oil test. 1/
06-101	Baldridge & Clayton, Fleming Well 1	Baldridge & Clayton	1956	3,254	--	--	--	375	--	--	--	--	Oil test. 1/
* 102	Clint Fouty	--	1905	10	26	--	Tm	353	4.5	Apr. 8, 1968	N	U	Brick lined to bottom. Caved from 13 to 31 ft.
* 103	J. F. Hamilton	--	Old	23	36	--	Tm	399	14.0	Apr. 25, 1962	B,H	D	Brick lined. Goes dry. Snakes in well.
* 201	R. L. Gowan	--	1930	45	30	--	Tm	330	41.0	Apr. 24, 1968	J,E 1/2	D	Brick lined to bottom. Never dry.
301	Three States Natural Gas Company, L. B. Bonner Well 1	Three States Natural Gas Company	1954	3,535	8	--	--	337	--	--	--	--	Oil test. 1/
* 401	--	--	1935	46	35	--	Tm	339	31.8	Apr. 4, 1968	J,E 3/5	S	Brick wall to bottom. Reported discharge 12 gpm.
501	--	--	Old	31	30	--	Tm	351	dry	May 2, 1962	N	U	Dry during wet spring of the year.
* 601	Berta Walker	--	Old	26	30	--	Twi	402	21.6	May 2, 1968	B,H	D	Brick wall to bottom.

See footnotes at end of table.

Table 6.--Records of Wells and Test Holes in Navarro County and Adjacent Areas--Continued

WELL	WELL OWNER OR NAME OF WELL	DRILLER	DATE COMPLETED	DEPTH OF WELL (FT)	CASING		WATER-BEARING UNITS	ALTITUDE OF LAND SURFACE (FT)	WATER LEVEL		METHOD OF LIFT	USE OF WATER	REMARKS
					DIAMETER (IN)	DEPTH (FT)			ABOVE (+) OR BELOW LAND SURFACE DATUM (FT)	DATE OF MEASUREMENT			
							Navarro County						
* TY-39-07-101	Carter-Gragg Oil Co., I. T. Kent	Carter-Gragg	1953	3,422	7	--	--	278	--	--	--	--	Oil test. [1]
102	Carter-Gragg Oil Co., J. I. Lewis Well 1	do.	1952	7,234	8	--	--	276	--	--	--	--	Oil test. [1]
* 103	--	--	Old	49	35	--	Tm	330	39.1	Apr. 4, 1969	J,E 3/4	S	Brick wall to bottom.
* 201	--	--	1955	16	42	--	Qal	268	4.9	Apr. 4, 1968	N	Irr,S	Brick wall.
* 301	Levi Jacobs	Levi Jacobs	--	58	32	--	Twi	311	49.2	Mar. 1, 1968	J,E 3/4	D	Smells of H_2S.
* 302	--	--	Old	47	36	--	Twi	308	46.4	Apr. 2, 1968	B,H	S	Brick wall. Rarely used.
401	Lawton Oil Corp., R. A. Neal Well A-1	Lawton Oil Co.	1953	6,960	--	--	--	338	--	--	--	--	Oil test. [1]
402	--	--	Old	38	36	--	Twi	382	dry	Apr. 24, 1968	N	U	
* 403	Joe Anderson	--	Old	55	37	--	Twi	378	38.3	do.	J,E 1/2	S,D	Abundantly used to fill 3 tanks for cattle. Never dry.
* 404	--	--	Old	30	36	--	Twi	382	28.6	Apr. 24, 1968	N	S	Rarely used.
* 11-101	Wayne Allard	--	Old	24	36	--	Ktaw	553	19.7	June 10, 1968	N	S	Brick wall to bottom. Rarely used.
12-101	Coats & Danciger Wickham Well 1	Coats & Danciger	1949	2,220	8	--	--	455	--	--	--	--	Oil test. [1]
* 201	--	--	Old	28	30	--	Knn	431	5.7	May 28, 1968	N	S	Brick wall. Rarely used.
* 401	--	--	Old	22	40	--	Kn	452	4.8	do.	N	D	Brick wall to bottom. Rarely used.
* 602	Floyd Calavy	--	Old	34	40	--	Tm	551	24.2	June 12, 1968	N	S	Rarely used.
603	Bond Oil Company, Miller Well 1	Bond Oil Company	1960	2,935	8	--	--	465	--	--	--	--	Oil test. [1]
* 13-101	--	--	Old	22	30	--	Tm	498	3.5	June 12, 1968	B,H	D	Brick wall to bottom.
* 201	M. H. Mandeville	--	Old	20	60	--	Tm	407	3.3	May 15, 1968	N	S	Rarely used.
* 401	--	--	Old	19	60	--	Tm	445	18.4	May 16, 1968	N	S	Rarely used.

See footnotes at end of table.

Table 6.--Records of Wells and Test Holes in Navarro County and Adjacent Areas--Continued

WELL	WELL OWNER OR NAME OF WELL	DRILLER	DATE COM-PLET-ED	DEPTH OF WELL (FT)	CASING DIAM-ETER (IN)	CASING DEPTH (FT)	WATER-BEAR-ING UNITS	ALTITUDE OF LAND SURFACE (FT)	WATER LEVEL ABOVE (+) OR BELOW LAND SURFACE DATUM (FT)	WATER LEVEL DATE OF MEASUREMENT	METHOD OF LIFT	USE OF WATER	REMARKS
							Freestone County						
* KA-39-08-101	B. Carpenter	--	1960	345	4	--	Twi	301	46.8	Mar. 1, 1968	J,E 1	D	Drilled and cased to bottom. Perforated 325-345 ft.
* 14-101	--	--	Old	21	36	--	Tm	410	16.3	May 15, 1968	N	S	Rarely used.
							Ellis County						
JK-33-49-101	R. S. LeSage	Lesco, Inc.	1944	2,898	8	--	--	710	--	--	--	--	Oil test. 1/
							Hill County						
LW-39-10-202	City of Hubbard, Well 3	J. L. Myers' Sons	1955	3,441	10,7	--	Kh	637	167.8	Dec. 12, 1967	T,E	P	Drilled and cased to bottom.

* For chemical analyses of water from wells, see Table 8.
1/ Electric log in files of U.S. Geological Survey or Texas Water Development Board, Austin, Texas.
2/ For drillers' logs of wells, see Table 7.

Table 7.—Selected Drillers' Logs of Water Wells, Navarro County

Well TY-33-52-802

Owner: City of Emhouse
Driller: Fred M. Allison

	THICKNESS (FEET)	DEPTH (FEET)
Surface soil	5	5
Clay	55	60
Shale	213	273
Rock	2	275
Shale	75	350
Rock	3	353
Shale	572	925
Austin chalk	402	1,327
Shale	93	1,420
Gumbo	80	1,500
Shale	188	1,688
Rock	2	1,690
Shale	4	1,694
Iron rock	6	1,700
Iron rock	4	1,704
Shale	4	1,708
Rock	1	1,709
Water sand	47	1,756
Rock	2	1,758
Sand and shale	5	1,763
Rock	2	1,765
Shale	35	1,800
Rock	1	1,801
Water sand	11	1,812
Lime	24	1,836
Shale	34	1,870
Rock	2	1,872
Shale	30	1,902
Rock	3	1,905
Shale	15	1,920
Gumbo	30	1,950
Rock	2	1,952
Water sand	18	1,970
Lime	47	2,017

Well TY-33-53-603

Owner: Roane Water Supply Corp.
Well No. 2
Driller: J. L. Myers' Sons

	THICKNESS (FEET)	DEPTH (FEET)
Surface soil	3	3
Clay	57	60
Shale	170	230
Sand	30	260
Shale	9	269

Well TY-33-59-102

Owner: City of Blooming Grove Well No. 2
Driller: John Allen (J. L. Myers' Sons)

	THICKNESS (FEET)	DEPTH (FEET)
Surface soil	4	4
Clay	12	16
Sand rock	3	19
Shale	521	540
Chalk rock	400	940
Shale	360	1,300
Sand rock	49	1,349
Broken sand rock and shale	23	1,372
Shale with sand streaks	26	1,398
Sandrock and shale	50	1,448
Broken sand	15	1,463
Sand	21	1,484
Sandrock	38	1,522
Shale and lime	28	1,550
Lime	10	1,560
Shale with lime streaks	66	1,626

Well TY-33-59-302

Owner: Town of Barry, Texas
Driller: Fred M. Allison

	THICKNESS (FEET)	DEPTH (FEET)
Surface soil	4	4
Clay	56	60
Shale	160	220
Rock	2	222
Shale	588	810
White lime	418	1,228
Shale	72	1,300

Table 7.—Selected Drillers' Logs of Water Wells, Navarro County—Continued

Well TY-33-59-302—Continued

	THICKNESS (FEET)	DEPTH (FEET)
Gumbo	80	1,380
Shale	171	1,551
Rock	8	1,559
Shale	12	1,571
Cap rock	1	1,572
Water sand	53	1,625
Rock	4	1,629
Shale	20	1,649
Rock	2	1,651
Shale	42	1,693
Rock	1	1,694
Sand and shale	17	1,711
Water sand	10	1,721

Well TY-33-61-102

Owner: City of Corsicana Well No. 5
Driller: H. G. Johnson

	THICKNESS (FEET)	DEPTH (FEET)
Sandy marl and clay	1,050	1,050
Marl and clay	500	1,550
Chalky blue and white limestone	430	1,980
Blue-black shale	420	2,400
Water-bearing sand	60	2,460
Blue clay	27	2,487
Sand	8	2,495
Shale	20	2,515

Table 8.--Chemical Analyses of Water From Wells in Navarro and Freestone Counties

(Analyses given are in milligrams per liter except specific conductance, pH, SAR, RSC, temperature, and percent sodium)

Water-bearing unit: Qal, Quaternary alluvium; Twi, Wilcox Group; Tm, Midway Group; Kn, Navarro Group (excluding Nacatoch Sand); Knn, Nacatoch Sand of the Navarro Group; Kta, Taylor Marl (excluding Wolfe City Sand Member); Ktaw, Wolfe City Sand Member of the Taylor Marl; Kwb, Woodbine Formation.

WELL	PRODUCING INTERVAL OR WELL DEPTH (FT)	WATER-BEARING UNIT	DATE OF COLLECTION	SILICA (SiO_2)	IRON (Fe)	CALCIUM (Ca)	MAGNESIUM (Mg)	SODIUM * AND POTASSIUM		BICARBONATE (HCO_3)	SULFATE (SO_4)	CHLORIDE (Cl)	FLUORIDE (F)	NITRATE (NO_3)	BORON (B)	DISSOLVED SOLIDS	HARDNESS AS $CaCO_3$	PERCENT SODIUM	SODIUM ADSORPTION RATIO (SAR)	RESIDUAL SODIUM CARBONATE (RSC)	SPECIFIC CONDUCTANCE (MICROMHOS AT 25° C)	pH	TEMPERATURE	
								Na	K														°C	°F
										Navarro County														
TY-33-45-602	25	Qal	Apr. 29, 1968	--	--	--	--	--		450	716	160	--	--	--	1,490a/	695	--	--	0.00	2,370	7.9	18	64
901	48	Knn	do.	--	--	--	--	--		240	774	820	--	137	--	2,630a/	1,440	--	--	.00	4,170	7.4	19	66
46-402	22	Qal	Apr. 30, 1968	15	--	100	7.1	16	9.0	316	19	25	0.4	12	--	358	278	11	0.4	.00	640	7.6	17	63
701	22	Qal	Apr. 26, 1968	--	--	--	--	--		118	6.4	2.8	--	--	--	142a/	103	--	--	.00	226	7.0	16	61
51-801	26	Ktaw	May 15, 1968	--	--	--	--	--		184	20	19	--	--	--	256a/	81	--	--	1.40	406	7.1	24	75
802	16	Kta	do.	17	--	72	15	290	2.9	300	544	41	.9	.8	--	1,130	241	72	8.1	.10	1,700	7.2	22	72
901	25	Ktaw	May 14, 1968	--	--	--	--	--		131	26	5.7	--	--	--	194a/	88	--	--	.39	308	7.1	18	64
902	24	Kta	July 3, 1968	--	--	--	--	--		200	31	21	--	--	--	301a/	164	--	--	.00	478	7.2	21	70
52-204	31	Kta	July 10, 1968	42	--	300	11	38	7.4	400	332	123	.2	60	--	1,110	794	9	.6	.00	1,550	7.8	20	68
401	35	Kta	May 14, 1968	19	--	58	4.0	37	6.7	184	16	58	.4	3.2	--	292	161	32	1.3	.00	522	7.5	19	66
501	34	Kta	Mar. 29, 1968	19	--	138	15	508	2.1	512	506	395	1.2	5.7	--	1,840	406	73	11	.27	2,860	7.6	17	63
502	35	Kta	July 9, 1968	--	--	76	7.2	--		244	76	150	--	169	--	825a/	219	--	--	.00	1,310	7.5	20	68
701	19	Kta	May 14, 1968	--	--	--	--	--		318	302	568	--	193	--	2,070a/	1,110	--	--	.00	3,290	7.3	17	63
702	19	Kta	July 9, 1968	--	--	48	6.5	--		218	44	21	--	--	--	318a/	146	--	--	.64	505	7.5	20	68
b/ 801	1,700-1,750	Kwb	Nov. 1956	--	4	6	3	1,180-1,240 c/		--	273	1,038	3.2	.4	--	3,840	28	--	--	--	--	7.6	--	--
801	do.	Kwb	July 5, 1961	17	0.22	8.5	3.1	do.		1,150	280	1,040	3.9	9.8	--	3,170	34	99	93	--	5,190	7.6	--	--
802	2,017	Kwb	Feb. 22, 1944	15	.32	9.4	3.0	1,040 c/		1,120d/	491	612	2.3	3.2	--	2,740	36	98	--	--	4,450	7.5	--	--
803	25	Kta	May 10, 1968	--	--	--	--	--		182	95	74	--	--	--	459a/	166	--	--	.00	730	7.4	19	66
901	38	Kn	July 4, 1968	--	--	--	--	--		127	2.2	5.3	--	--	--	157a/	79	--	--	.50	249	7.0	20	68
53-101	15	Kn	Apr. 30, 1968	--	--	--	--	--		286	37	6.0	--	--	--	361a/	202	--	--	.65	573	7.8	17	63
102	13	Kn	May 1, 1968	--	--	--	--	--		210	31	5.6	--	--	--	259a/	77	--	--	1.90	411	7.5	18	64
201	44	Knn	Apr. 30, 1968	--	--	--	--	--		262	56	141	--	136	--	775a/	480	--	--	.00	1,230	7.5	19	66
202	34	Knn	July 10, 1968	36	--	94	2.8	68	1.4	399	12	39	.4	4.8	--	454	246	37	1.9	1.62	734	7.7	21	70
401	16	Kn	May 1, 1968	--	--	--	--	--		190	11	4.9	--	--	--	210a/	143	--	--	.25	338	7.5	19	66
501	39	Knn	July 11, 1968	--	--	128	4.1	--		368	22	56	--	--	--	515a/	336	--	--	.00	818	7.6	21	70
b/ 602	224-249	Knn	July 10, 1962	--	.72	2	6	560 c/		551	354	258	.5	.4	--	1,860	30	--	--	--	3,100	8.2	--	--
602	do.	Knn	Feb. 7, 1968	11	.20	4.5	.7	526	2.3	558	320	270	1.5	1.8	4.8	1,420	14	99	61	8.87	2,300	8.1	22	72
603	230-255	Knn	do.	13	.09	5.0	.8	611	2.4	620	236	412	1.8	1.2	5.6	1,590	16	99	66	9.84	2,600	8.0	23	73
604	70	Kn	Apr. 23, 1968	--	--	--	--	--		224	134	14	--	--	--	433a/	40	--	--	2.87	687	7.4	--	--
701	36	Knn	May 1, 1968	--	--	--	--	--		286	624	218	--	108	--	1,420a/	1,020	--	--	.00	2,250	7.5	18	64

See footnotes at end of table.

Table 8.--Chemical Analyses of Water From Wells in Navarro and Freestone Counties--Continued

WELL	PRODUCING INTERVAL OR WELL DEPTH (FT)	WATER-BEARING UNIT	DATE OF COLLECTION	SILICA (SiO_2)	IRON (Fe)	CAL-CIUM (Ca)	MAGNE-SIUM (Mg)	SODIUM * AND POTASSIUM Na	K	BICAR-BONATE (HCO_3)	SUL-FATE (SO_4)	CHLO-RIDE (Cl)	FLUO-RIDE (F)	NITRATE (NO_3)	BORON (B)	DIS-SOLVED SOLIDS	HARD-NESS AS $CaCO_3$	PERCENT SODIUM	SODIUM ADSORP-TION RATIO (SAR)	RESIDUAL SODIUM CARBONATE (RSC)	SPECIFIC CONDUCTANCE (MICROMHOS AT 25° C)	pH	TEMPER-ATURE °C	°F
										Navarro County														
TY-39-04-401	1,700-1,740	Kwb	June 29, 1961	18	0.80	7.5	4.0	1,250 c/		1,170	158	1,140	4.2	2.0	--	3,160	35	99	92	--	5,290	7.7	--	--
401	do.	Kwb	May 8, 1968	18	1.2	11	5.3	1,390	5.3	1,160	69	1,420	4.8	1.1	7.7	3,500	50	98	85	18.00	6,060	7.5	33	91
501	43	Kn	May 29, 1968	37	--	204	20	264	14	572	552	92	2.5	24	--	1,490	592	49	4.7	.00	2,150	7.1	19	66
601	100- 120	Knn	May 9, 1968	16	.01	1.8	.2	310	1.3	560	33	130	.8	2.0	.83	771	6	99	55	9.07	1,310	8.2	21	70
604	do.	Knn	July 5, 1961	15	1.2	3.5	1.6	371 c/		540	25	248	1.0	1.0	--	932	15	98	42	--	1,620	7.7	--	--
609	15- 39	Knn	May 30, 1968	--	--	47	3.2	--		206	10	5.6	--	--	--	238a/	130	--	--	.77	377	7.3	19	66
801	40	Kn	May 28, 1968	--	--	--	--	--		168	782	86	--	--	--	1,180a/	815	--	--	.00	1,870	7.4	19	66
05-102	28	Kn	May 20, 1968	--	--	--	--	--		44	5.8	7.8	--	--	--	92a/	32	--	--	.08	146	6.3	19	66
103	77	Knn	May 23, 1968	27	.11	41	3.8	202	2.4	400	114	84	.4	.4	--	672	118	78	8.1	4.20	1,090	7.1	21	70
104	70	Knn	do.	--	.06	--	--	--		492	118	75	--	--	--	750a/	210	--	--	3.86	1,190	7.7	22	72
304	24	Tm	Apr. 25, 1968	--	--	--	--	--		98	8.4	4.6	--	--	--	116a/	94	--	--	.00	184	6.3	17	63
401	16	Tm	June 13, 1968	--	--	110	4.8	--		344	18	9.0	--	--	--	375a/	294	--	--	.00	595	7.6	22	72
501	42	Tm	May 3, 1968	62	--	395	80	299	10	180	1,660	62	3.5	6.2	--	2,670	1,310	33	3.6	.00	3,120	7.4	20	68
502	33	Tm	do.	--	--	--	--	--		250	557	47	--	--	--	926a/	655	--	--	.00	1,470	7.8	21	70
703	24	Tm	May 16, 1968	4.8	--	5.2	1.3	4.4	1.8	32	.0	1.9	.1	1.4	--	37	18	32	.5	.16	67	6.5	21	70
704	26	Tm	June 30, 1968	--	--	29	.8	--		82	12	1.0	--	--	--	105a/	76	--	--	.00	167	6.9	21	70
06-102	10	Tm	Apr. 8, 1968	--	--	--	--	--		92	.4	2.1	--	--	--	103a/	74	--	--	.03	164	6.8	16	61
103	23	Tm	Apr. 25, 1968	28	--	86	13	128	1.2	416	98	80	.6	1.0	--	641	268	51	3.4	1.46	1,040	7.5	18	64
201	45	Tm	Apr. 24, 1968	--	--	--	--	--		366	46	51	--	--	--	508a/	170	--	--	2.60	807	7.4	20	68
401	46	Tm	Apr. 4, 1968	32	--	198	28	264	2.0	554	126	388	.4	57	--	1,370	609	48	4.6	.00	2,270	7.4	18	64
601	26	Twi	May 2, 1968	--	--	--	--	--		182	117	502	--	86	--	1,420a/	325	--	--	.00	2,250	7.2	18	64
07-103	49	Tm	Apr. 2, 1968	--	--	--	--	--		438	40	215	--	--	--	851a/	522	--	--	.00	1,350	7.4	19	66
201	16	Qal	Apr. 4, 1968	18	--	70	2.7	29	5.0	212	50	16	.7	2.8	--	298	186	25	.9	.00	476	7.6	13	54
301	58	Twi	Mar. 1, 1968	34	--	482	25	54	2.9	578	760	112	.3	.0	--	1,750	1,310	8	.6	.00	2,220	6.9	--	--
302	47	Twi	Apr. 2, 1968	--	--	--	--	--		558	549	225	--	--	--	1,400a/	1,140	--	--	.00	2,230	7.0	19	66
403	55	Twi	Apr. 24, 1968	47	.12	50	20	55	2.9	127	50	120	.8	4.1	--	412	208	36	1.7	.00	720	6.7	19	66
404	30	Twi	do.	--	--	--	--	--		165	13	3.2	--	--	--	192a/	140	--	--	.00	304	7.1	16	61
11-101	24	Ktaw	June 10, 1968	29	--	244	34	177	16	332	462	81	1.3	322	--	1,520	749	33	2.7	.00	2,100	7.2	19	66
12-201	28	Knn	May 28, 1968	--	--	--	--	--		222	378	79	--	--	--	869a/	360	--	--	.00	1,380	7.7	19	66
401	22	Kn	do.	28	--	390	45	368	4.0	330	1,210	290	.6	93	--	2,600	1,160	41	4.7	.00	3,370	7.0	18	64
602	34	Tm	June 12, 1968	24	--	143	11	79	8.9	434	8.2	143	.2	9.9	--	640	402	29	1.7	.00	1,150	7.4	19	66
13-101	22	Tm	do.	--	--	70	9.5	--		288	25	6.8	--	--	--	364a/	214	--	--	.45	578	7.5	21	70
201	20	Tm	May 15, 1968	12	--	18	3.3	4.9	7.4	76	3.6	5.8	.4	3.0	--	95	58	14	.3	.08	159	7.0	19	66

See footnotes at end of table.

Table 8.--Chemical Analyses of Water From Wells in Navarro and Freestone Counties--Continued

WELL	PRODUCING INTERVAL OR WELL DEPTH (FT)	WATER-BEARING UNIT	DATE OF COLLECTION	SILICA (SiO_2)	IRON (Fe)	CAL-CIUM (Ca)	MAGNE-SIUM (Mg)	SODIUM * AND POTASSIUM		BICAR-BONATE (HCO_3)	SUL-FATE (SO_4)	CHLO-RIDE (Cl)	FLUO-RIDE (F)	NITRATE (NO_3)	BORON (B)	DIS-SOLVED SOLIDS	HARD-NESS AS $CaCO_3$	PERCENT SODIUM	SODIUM ADSORP-TION RATIO (SAR)	RESIDUAL SODIUM CARBONATE (RSC)	SPECIFIC CONDUCTANCE (MICROMHOS AT 25° C)	pH	TEMPER-ATURE	
								Na	K														°C	°F
											Navarro County													
TY-33-62-102	28	Tm	July 12, 1968	24	--	120	15	93	1.7	244	50	210	0.7	12	--	646	361	36	2.1	0.00	1,190	7.4	20	68
103	23	Tm	July 15, 1968	--	--	350	35	--		211	94	225	--	693	--	1,510a/	1,020	--	--	.00	2,390	7.0	21	70
201	37	Tm	May 27, 1968	18	0.08	70	7.9	254	1.6	380	17	295	1.1	15	--	867	207	73	7.7	2.09	1,550	7.6	--	--
202	16	Tm	do.	--	--	--	--	--		372	37	645	--	--	--	1,600a/	950	--	--	.00	2,540	7.0	--	--
203	25	Tm	do.	--	--	--	--	--		256	39	106	--	62	--	680a/	260	--	--	.00	1,080	7.4	--	--
302	39	Tm	Apr. 5, 1968	26	--	108	8.7	48	1.2	364	74	22	.5	5.8	--	473	306	25	1.2	.00	760	7.6	19	66
303	34	Tm	July 17, 1968	--	--	98	5.3	--		332	16	34	--	--	--	420a/	266	--	--	.11	666	7.5	21	70
501	20	Tm	May 3, 1968	--	--	--	--	--		182	77	44	--	100	--	490a/	252	--	--	.00	777	7.7	19	66
601	34	Tm	July 17, 1968	--	--	124	11	--		222	38	100	--	110	--	585a/	354	--	--	.00	929	7.5	19	66
702	24	Tm	July 16, 1968	--	--	40	5.5	--		194	24	9.4	--	57	--	282a/	122	--	--	.73	447	6.7	22	72
802	26	Tm	July 17, 1968	--	--	162	29	--		288	360	400	--	112	--	1,540a/	524	--	--	.00	2,450	7.6	20	68
902	32	Tm	Apr. 5, 1968	--	--	--	--	--		350	23	48	--	--	--	471a/	224	--	--	1.26	748	7.3	--	--
903	39	Tm	do.	--	--	--	--	--		366	34	68	--	--	--	528a/	120	--	--	3.60	838	7.7	19	66
63-101	33	Tm	Mar. 22, 1968	21	--	86	7.3	90	2.0	400	12	65	1.2	2.6	--	484	244	44	2.5	1.67	826	7.4	--	--
202	48	Tm	Mar. 28, 1968	--	--	--	--	--		356	79	52	--	--	--	536a/	256	--	--	.71	851	7.3	19	66
501	30	Tm	Mar. 22, 1968	--	--	--	--	--		36	3.4	1.4	--	--	--	50a/	31	--	--	.00	80	6.4	--	--
603	54	Tm	Mar. 28, 1968	27	--	118	8.8	72	2.1	372	6.4	89	.5	57	--	564	330	32	1.7	.00	950	7.4	19	66
803	56	Tm	Mar. 25, 1968	--	--	--	--	--		396	34	34	--	--	--	476a/	228	--	--	1.93	756	7.6	21	70
901	58	Twi	Mar. 18, 1968	32	.00	298	14	17	2.4	540	162	93	.3	113	--	998	801	4	.3	.00	1,500	7.0	--	--
64-702	31	Twi	Mar. 29, 1968	--	--	--	--	--		436	206	328	--	--	--	1,270a/	630	--	--	.00	2,020	7.0	18	64
703	24	Twi	do.	25	.04	292	57	240	4.2	186	528	472	.6	127	--	1,840	963	35	3.4	.00	2,790	7.2	16	61
39-02-203	37	Kta	July 3, 1968	27	.06	.98	9.8	156	6.1	390	94	104	.6	82	--	770	285	54	4.0	.69	1,260	7.1	21	70
301	32	Kta	do.	26	--	--	--	--		436	48	41	--	--	--	563a/	172	--	--	3.71	894	7.3	20	68
302	36	Ktaw	July 5, 1968	30	--	142	16	277	2.0	384	174	368	.4	10	--	1,210	420	59	5.9	.00	2,040	7.5	21	70
901	15	Ktaw	June 14, 1968	--	--	110	8.5	--		384	4.4	2.4	--	--	--	372a/	310	--	--	.10	590	7.4	22	72
03-101	16	Ktaw	June 3, 1968	--	--	39	3.6	--		140	7.2	1.6	--	--	--	161a/	112	--	--	.05	255	7.1	19	66
301	14	Kta	July 5, 1968	--	--	60	5.8	--		236	25	21	--	--	--	298a/	174	--	--	.40	473	7.6	23	73
402	20	Ktaw	June 4, 1968	--	--	86	10	--		324	4.0	8.6	--	--	--	335a/	256	--	--	.20	531	7.7	22	72
501	25	Kta	do.	27	--	184	11	23	3.7	342	38	94	.5	117	--	666	504	9	.4	.00	1,110	7.6	23	73
601	27	Qal	May 24, 1968	--	--	--	--	--		150	21	12	--	--	--	211a/	124	--	--	.00	335	7.2	20	68
701	18	Ktaw	June 4, 1968	--	--	62	8.2	--		236	44	7.2	--	--	--	303a/	188	--	--	.10	481	7.8	19	66
04-201	30	Kta	May 24, 1968	--	--	--	--	--		222	94	200	--	--	--	781a/	244	--	--	.00	1,240	7.7	21	70
b/ 401	1,700-1,740	Kwb	Mar. 1957	--	.22	10	5	1,475 c/		--	127	1,358	4.0	.4	--	3,680	45	--	--	--	6,133	7.7	--	--

See footnotes at end of table.

Table 8.--Chemical Analyses of Water From Wells in Navarro and Freestone Counties--Continued

WELL	PRODUCING INTERVAL OR WELL DEPTH (FT)	WATER-BEARING UNIT	DATE OF COLLECTION	SILICA (SiO_2)	IRON (Fe)	CALCIUM (Ca)	MAGNESIUM (Mg)	SODIUM * AND POTASSIUM		BICARBONATE (HCO_3)	SULFATE (SO_4)	CHLORIDE (Cl)	FLUORIDE (F)	NITRATE (NO_3)	BORON (B)	DISSOLVED SOLIDS	HARDNESS AS $CaCO_3$	PERCENT SODIUM	SODIUM ADSORPTION RATIO (SAR)	RESIDUAL SODIUM CARBONATE (RSC)	SPECIFIC CONDUCTANCE (MICROMHOS AT 25° C)	pH	TEMPERATURE	
								Na	K														°C	°F
											Navarro County													
e/ TY-33-59-102	1,402-1,514	Kwb	Oct. 27, 1966	--	0.2	4.8	1.9	874 c/		1,030 d/	504	390	1.9	0.5	--	2,754	20	--	--	--	3,000	8.2	--	--
102	do.	Kwb	Feb. 9, 1968	16	.43	3.5	1.4	846	2.9	1,040	492	360	6.1	.8	7.4	2,250	14	99	98	16.8	3,520	8.2	34	93
104	20	Ktaw	May 15, 1968	--	--	--	--	--		127	47	23	--	--	--	249a/	55	--	--	.98	395	7.1	22	72
105	6	Ktaw	do.	--	--	--	--	--		163	3.4	1.2	--	--	--	179a/	134	--	--	.00	284	7.5	24	75
201	34	Ktaw	May 16, 1968	--	--	--	--	--		282	702	362	--	--	--	1,760a/	835	--	--	.00	2,800	7.8	20	68
202	12- 26	Ktaw	July 3, 1968	24	--	84	8.6	111	2.7	408	35	62	.6	28	--	557	245	49	3.1	1.79	943	7.2	20	68
203	22	Ktaw	do.	--	--	--	--	--		550	33	62	--	--	--	680a/	168	--	--	5.65	1,080	7.3	19	66
b/ 301	1,610-1,650	Kwb	June 1959	--	.35	9	1	970 c/		--	330	720	4.3	.4	--	3,000	23	--	--	--	5,000	8.0	--	--
301	do.	Kwb	Jan. 26, 1968	9.1	5.8	218	59	3,420	15	172	9.1	5,820	1.0	24	5.7	9,670	786	90	--	--	16,900	7.3	36	97
302	1,572-1,721	Kwb	Feb. 22, 1944	14	.14	4.8	1.5	946	9	1,080 d/	351	588	2.2	2.2	--	2,450	18	99	--	--	4,010	7.6	--	--
303	18	Ktaw	May 15, 1968	--	--	--	--	--		202	100	2.4	--	--	--	323a/	274	--	--	.00	512	7.4	24	75
401	37	Ktaw	June 11, 1968	--	--	140	11	--		292	120	248	--	--	--	806a/	394	--	--	.00	1,280	7.8	19	66
502	35	Ktaw	June 25, 1968	--	--	845	38	128	1.1	234	153	615	1.1	1,640	--	3,560	2,260	11	1.2	.00	5,010	6.9	18	64
701	19	Ktaw	June 7, 1968	--	--	--	--	--		248	822	655	--	--	--	2,440a/	1,010	--	--	.00	3,870	7.2	22	72
801	24	Kta	May 17, 1968	--	--	--	--	--		198	10	15	--	--	--	243a/	168	--	--	.00	386	7.6	19	66
f/ 60-202	1,835-1,980	Kwb	Feb. 16, 1952	--	.05	--	--	1,222 c/		--	--	1,032	--	--	--	3,691	--	--	--	--	--	--	--	--
401	17	Kta	May 16, 1968	--	--	--	--	--		132	153	18	--	--	--	374a/	202	--	--	.00	593	7.5	21	70
501	11	Kn	May 17, 1968	--	--	--	--	--		106	16	5.6	--	--	--	145a/	92	--	--	.00	230	7.1	22	72
701	17	Kta	do.	--	--	--	--	--		60	8.0	1.5	--	--	--	79a/	56	--	--	.00	126	6.8	20	68
801	26	Kn	May 16, 1968	22	--	52	7.5	156	4.0	502	59	16	1.8	10	--	575	160	67	5.4	5.02	928	7.7	22	72
803	11	Kta	do.	--	--	--	--	--		113	29	3.2	--	--	--	166a/	86	--	--	.13	264	7.1	23	73
804	18	Kta	do.	--	--	--	--	--		152	880	960	--	2,190	--	4,760a/	3,120	--	--	.00	7,550	7.2	24	75
901	26	Knn	May 23, 1968	--	--	--	--	--		137	14	3.7	--	--	--	171a/	78	--	--	.68	272	7.3	19	66
61-102	2,515	Kwb	May 1, 1938	--	.12	13	5.4	1,810 c/		1,580	153	1,790	2.5	--	--	4,550	55	99	--	--	--	--	--	--
301	35	Kn	July 11, 1968	--	--	278	40	--		608	862	215	--	--	--	1,860a/	858	--	--	.00	2,950	7.5	21	70
302	23	Kn	July 15, 1968	22	--	86	5.9	70	9.8	320	88	26	.5	10	--	475	239	38	2.0	.46	772	7.6	22	72
401	117- 127	Knn	May 21, 1968	28	2.0	11	3.8	290	2.1	448	129	132	.7	.6	--	817	43	93	19	6.48	1,350	7.4	22	72
402	162- 181	Knn	May 30, 1968	22	.39	7.2	1.4	317	12	476 d/	118	150	.8	.1	--	862	24	95	28	7.33	1,460	8.5	23	73
701	48	Kn	May 21, 1968	27	--	99	11	146	31	426	187	53	.7	1.7	--	738	292	52	3.7	1.14	1,150	7.2	19	66
702	208- 241	Knn	June 13, 1968	11	.07	7.8	1.2	582	2.6	514	205	455	1.0	11	--	1,530	24	98	52	7.93	2,680	7.9	24	75
804	22	Kn	May 21, 1968	--	--	--	--	--		151	46	74	--	25	--	393a/	101	--	--	.45	624	7.0	18	64
903	31	Tm	Apr. 4, 1968	--	--	--	--	--		400	20	53	--	--	--	497a/	228	--	--	2.00	789	7.5	18	64
904	32	Tm	July 16, 1968	--	--	65	11	--		306	17	27	--	77	--	428a/	207	--	--	.88	680	7.2	22	72

See footnotes at end of table.

Table 8.--Chemical Analyses of Water From Wells in Navarro and Freestone Counties--Continued

WELL	PRODUCING INTERVAL OR WELL DEPTH (FT)	WATER-BEARING UNIT	DATE OF COLLECTION	SILICA (SiO_2)	IRON (Fe)	CAL-CIUM (Ca)	MAGNE-SIUM (Mg)	SODIUM * AND POTASSIUM Na	K	BICAR-BONATE (HCO_3)	SUL-FATE (SO_4)	CHLO-RIDE (Cl)	FLUO-RIDE (F)	NITRATE (NO_3)	BORON (B)	DIS-SOLVED SOLIDS	HARD-NESS AS $CaCO_3$	PERCENT SODIUM	SODIUM ADSORP-TION RATIO (SAR)	RESIDUAL SODIUM CARBONATE (RSC)	SPECIFIC CONDUCTANCE (MICROMHOS AT 25° C)	pH	TEMPER-ATURE °C	°F
											Navarro County													
TY-33-53-801	29	Knn	July 11, 1968	32	--	216	20	249	17	472	130	445	0.4	24	--	1,370	622	46	4.3	0.00	2,370	7.3	20	68
54-103	31	Qal	Apr. 17, 1968	11	--	84	7.8	351	3.7	420	240	285	.3	7.4	--	1,200	242	76	9.8	2.05	1,990	7.6	19	66
201	20- 26	Qal	Apr. 12, 1968	12	--	295	29	420	6.0	354	692	540	--	1.2	.34	2,170	856	51	6.3	.00	3,250	7.0	--	--
301	18	Twi	do.	30	--	170	14	82	4.0	386	210	76	.3	21	--	797	482	27	1.6	.00	1,200	7.4	16	61
302	46	Twi	Apr. 16, 1968	29	0.03	94	5.8	15	4.0	310	20	9.0	.4	2.6	--	332	258	11	.4	.00	532	7.4	18	64
401	18	Kn	Apr. 23, 1968	--	--	--	--	--		182	24	4.2	--	--	--	222a/	128	--	--	.42	352	7.2	16	61
501	16	Tm	Apr. 11, 1968	--	--	--	--	--		164	8.4	3.5	--	--	--	181a/	114	--	--	.41	288	7.3	15	59
502	19	Tm	Apr. 15, 1968	--	--	--	--	--		110	173	43	--	--	--	441a/	180	--	--	.00	700	7.2	16	61
602	38	Tm	Apr. 11, 1968	--	--	--	--	--		288	290	640	--	403	--	2,170a/	1,080	--	--	.00	3,450	7.2	18	64
701	29	Kn	Apr. 15, 1968	--	--	--	--	--		282	16	36	--	--	--	362a/	180	--	--	1.02	575	7.7	18	64
702	28	Kn	Apr. 18, 1968	--	--	--	--	--		316	69	169	--	68	--	781a/	480	--	--	.00	1,240	7.2	17	63
703	31	Kn	do.	--	--	--	--	--		170	20	22	--	14	--	263a/	140	--	--	.00	418	7.2	18	64
803	36	Tm	Apr. 9, 1968	--	--	--	--	--		400	19	78	--	--	--	607a/	188	--	--	2.80	964	7.6	18	64
804	31	Tm	Apr. 18, 1968	--	--	--	--	--		332	9.6	181	--	73	--	769a/	480	--	--	.00	1,220	7.2	16	61
55-101	31	Twi	Apr. 16, 1968	--	--	--	--	--		246	58	57	--	.2	--	425a/	140	--	--	1.23	674	7.5	18	64
401	20	Tm	Apr. 10, 1968	--	--	--	--	--		248	154	182	--	64	--	851a/	438	--	--	.00	1,350	7.3	16	61
402	26	Tm	do	--	--	--	--	--		240	96	80	--	107	--	626a/	276	--	--	.00	994	7.5	18	64
403	30	Tm	Apr. 11, 1968	--	--	--	--	--		324	11	166	--	168	--	888a/	480	--	--	.00	1,410	7.6	18	64
501	15	Twi	Apr. 10, 1968	45	.03	44	10	28	2.1	91	44	58	.7	11	--	288	151	28	1.00	.00	449	6.7	14	57
701	34	Tm	Apr. 9, 1968	--	--	90	12	92	2.2	324	25	80	.7	96	--	576	274	42	2.4	.00	955	7.6	19	66
702	61	Tm	July 11, 1968	25	--	260	33	79	2.6	336	10	422	.5	88	--	1,090	784	18	1.2	.00	2,040	7.1	--	--
801	23	Twi	Feb. 16, 1968	--	--	--	--	--		114	103	102	--	--	--	451a/	190	--	--	.00	716	6.9	13	55
902	44	Twi	Feb. 27, 1968	25	--	320	42	146	8.0	484	604	183	.3	.0	--	1,570	971	24	2.0	.00	2,140	7.5	19	66
58-501	1,164-1,184	Kwb	Feb. 21, 1944	14	.03	3.5	1.1	594	10	812 d/	441	131	2.1	4.4	--	1,600	13	98	--	--	2,510	7.8	34	93
b/ 501	do.	Kwb	Sept. 1958	--	.1	4	1	581c/	--	--	398	145	4.0	2.7	--	1,680	14	--	--	--	2,800	8.0	--	--
501	do.	Kwb	July 18, 1968	13	.00	3.8	1.9	594	2.0	814 d/	416	135	.5	2.9	4.5	1,570	18	98	61	11.3	2,450	8.4	34	93
502	1,290	Kwb	do.	13	--	3.5	1.6	846	3.1	924	372	500	4.7	.5	--	2,200	15	99	95	14.8	3,560	8.2	--	--
602	18	Kta	June 6, 1968	--	--	--	--	--		87	17	2.6	--	--	--	139a/	91	--	--	.00	220	7.2	21	70
701	1,100 ±	Kwb	June 11, 1968	12	--	5.8	1.6	672	1.3	708	520	252	4.6	11	--	1,830	21	98	64	11.2	2,940	7.9	27	81
702	16	Kta	June 14, 1968	--	--	40	2.4	--		200	17	8.8	--	--	--	239a/	110	--	--	1.08	379	7.5	22	72
801	20	Kta	June 5, 1968	--	--	--	--	--		186	115	101	--	38	--	617a/	230	--	--	.00	980	7.4	18	64
59-101	1,401-1,450	Kwb	Feb. 21, 1944	14	.05	6.2	2.4	981	9.2	1,110 d/	172	760	2.4	7.1	--	2,500	26	98	--	--	4,220	7.7	--	--
b/ 101	do.	Kwb	June 1959	--	.2	8	1	970 c/		--	215	720	4.2	3.5	--	2,850	26	--	--	--	4,750	7.9	--	--

See footnotes at end of table.

Table 8.--Chemical Analyses of Water From Wells in Navarro and Freestone Counties--Continued

WELL	PRODUCING INTERVAL OR WELL DEPTH (FT)	WATER-BEARING UNIT	DATE OF COLLECTION	SILICA (SiO_2)	IRON (Fe)	CAL-CIUM (Ca)	MAGNE-SIUM (Mg)	SODIUM * AND POTASSIUM		BICAR-BONATE (HCO_3)	SUL-FATE (SO_4)	CHLO-RIDE (Cl)	FLUO-RIDE (F)	NITRATE (NO_3)	BORON (B)	DIS-SOLVED SOLIDS	HARD-NESS AS $CaCO_3$	PERCENT SODIUM	SODIUM ADSORP-TION RATIO (SAR)	RESIDUAL SODIUM CARBONATE (RSC)	SPECIFIC CONDUCTANCE (MICROMHOS AT 25° C)	pH	TEMPER-ATURE	
								Na	K														°C	°F
Navarro County																								
TY-39-13-401	19	Tm	May 16, 1968	--	--	--	--	--		70	56	16	--	352	--	621a/	378	--	--	0.00	986	6.7	18	64
Freestone County																								
KA-39-08-101	325- 345	Twi	Mar. 1, 1968	13	--	16	2.4	347	1.9	538	5.4	250	0.7	.5	--	902	50	93	21	7.82	1,570	7.8	--	--
14-101	21	Tm	May 15, 1968	--	--	--	--	--		104	101	388	--	477	--	1,510a/	800	--	--	.00	2,400	6.6	18	64

a/ Values are approximate dissolved solids based on relationship between measured specific conductance (micromhos at 25°C) and known amount of dissolved solids from analyses in Navarro County (Hem, 1959, p. 40). Specific conductance (micromhos at 25°C) x factor K (where K = 0.63) = approximate dissolved solids (mg/1).
b/ Analysis made by Texas State Department of Health, Austin, Texas.
c/ Sodium and potassium calculated as sodium (Na).
d/ Contains equivalent of any carbonate present.
e/ Analysis made by Pope Testing Laboratories, Houston, Texas.
f/ Drill-stem test conducted by Schlumberger Well Surveying Corporation and City of Corsicana Water Department.